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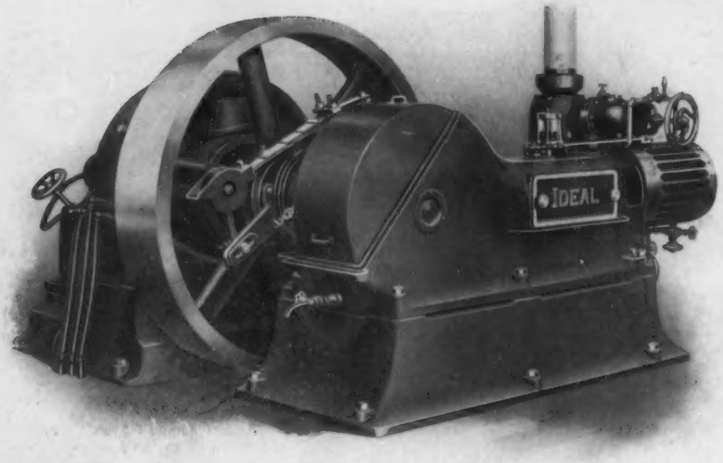

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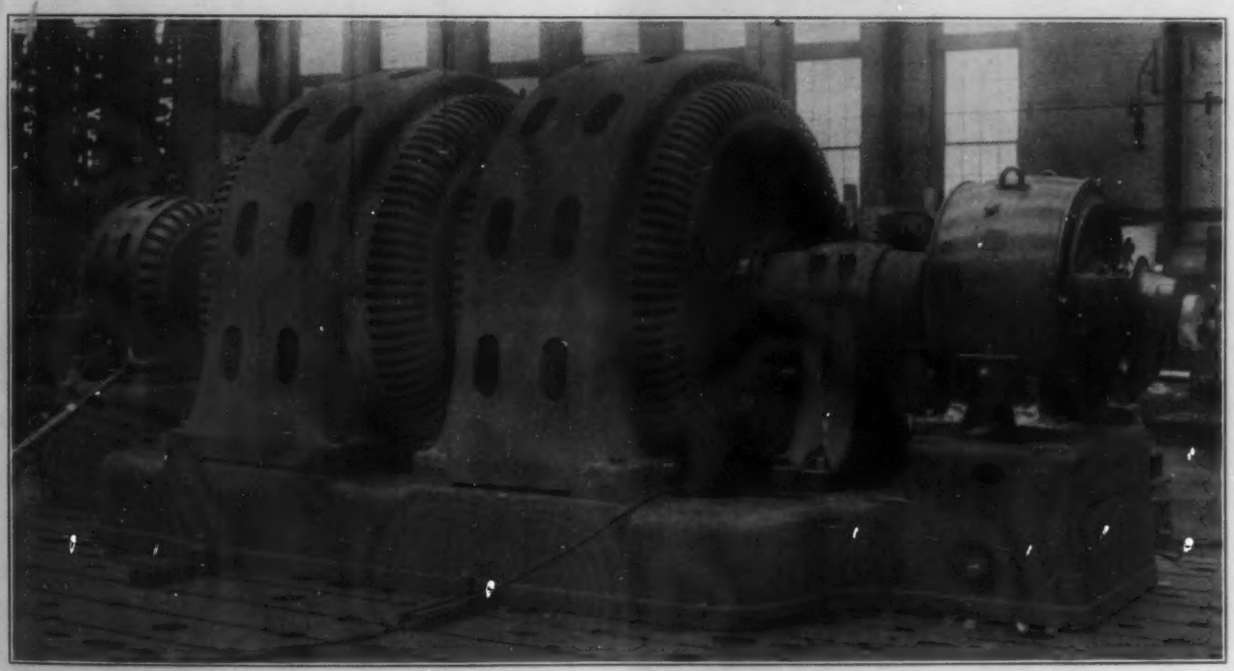
STARTING INDUCTION MOTORS

BY G. A. SCHNEIDER.

At a recent meeting of the San Francisco Section of the American Institute of Electrical Engineers a paper entitled "The Induction Generator," by Mr. F. G. Baum, was presented. This paper explained by means of numerous graphical diagrams and curves the action of the induction machine in its ordinary function as a motor, and the corresponding action as a generator. The discussion following was interesting, although brief.

The discussion recalled to the writer's mind another interesting question in reference to starting induction machines, not, however, as generators, but in the ordinary use as a motor. The question is one of determining the correct connections for a given direction of rotation. In numerous sub-stations motor-generator sets consisting of induction motors driving direct current generators are used. Sets of this kind are commonly started from the direct current side,



1500-h.p. 25-cycle Induction Motor driving 1000-kw. 60-cycle Generator. Starting Motor at the left—Exciter at the right.

In the writer's opinion, those present were mostly interested in the manner of starting an induction generator. It was shown that when first connected to the system the induction generator takes a heavy rush of current for the first few cycles of operation, the amount of this current depending upon whether the machine is connected when above or below synchronism, and to a certain extent upon the characteristics of the machine. This first rush of current may be limited by suitable reactive coils connected in the generator leads and short-circuited after starting.

especially in large distributing systems, the generator during starting operating as a motor. After the set has been brought up to approximately normal speed the line switch of the motor is closed. Should the motor leads not be connected to produce the same direction of rotation as that of the set at starting, the result would be a considerable strain upon the motor windings, shaft and other parts, or a disturbance upon the supply system. In connection with sets having a separate starting motor in addition to the regular driving motor, it it necessary to determine if direction of

rotation in both motors will be alike. When started for the first time, it is frequently convenient and in some cases necessary to know the direction of rotation for the motor of the set.

Most readers are familiar with the method of "phasing out" synchronous motors similarly used, as this subject has been fully covered by numerous publications, but do not so readily understand the test for induction motors. This is probably due to the fact that a synchronous motor is an active element on the system; that is, produces its own individual electromotive force when driven by another source, and with its field properly excited, while the induction motor (as will be shown later) will not have an electromotive force at its terminals until at least one set of windings is connected to the supply mains.

A method of making the required rotation tests for induction motors which should interest those doing construction work is outlined in the following paragraphs.

The principle of this test depends upon the action of a polyphase induction motor as a phase converter. The theory of a motor so used will be discussed briefly for the benefit of those who are not informed on this subject.

Transformation from one polyphase system to another is readily effected in an efficient manner by stationary transformers, but a single phase cannot be changed into a polyphase system with such simple apparatus.

The flow of energy in a single phase system is pulsating and in a polyphase system steady; thus, conversion from the former to the latter requires apparatus capable of storing energy during the period that the single phase input is greater than the polyphase output, and returning this stored energy into the polyphase system during the time the single phase input is less than the polyphase output. Both synchronous and induction motors meet these requirements, since by means of their revolving magnetic fields they supply currents and electromotive forces displaced in phase from those of the supply system, and can further store energy in the revolving elements. Machines used in this manner are known as phase converters. In this article only the induction motor used in this manner will be considered.

The paper heretofore mentioned shows plainly that the induction machine can operate either as a motor running below synchronism or as a generator above synchronism.

The motor and generator action may also occur simultaneously in one machine; part of the primary windings acting as motor circuits and others as generator circuits. Hence, if a polyphase motor is run single phase, electromotive forces will be induced in the idle windings. These electromotive forces will be displaced in phase depending upon the angular displacement of the idle windings from the primary phase.

Thus, a two-phase motor operated single phase will have electromotive forces induced in the idle winding which are approximately 90 degrees displaced from those in the active winding, and which when combined with the single phase supply circuit will give a two-phase system; or briefly stated, the motor will give two-phase current at its terminals. Likewise, a three-phase motor similarly operated will give three-phase current at its terminals.

The induction motor as a phase converter represents an instance of double transformation, the energy being first transformed from the primary or motor circuit to the secondary or rotor, and from the secondary to the other primary windings or generator circuits, which are also known as the tertiary windings.

Due to the internal losses in the machine and the magnetic leakage at the air gap, there is a considerable

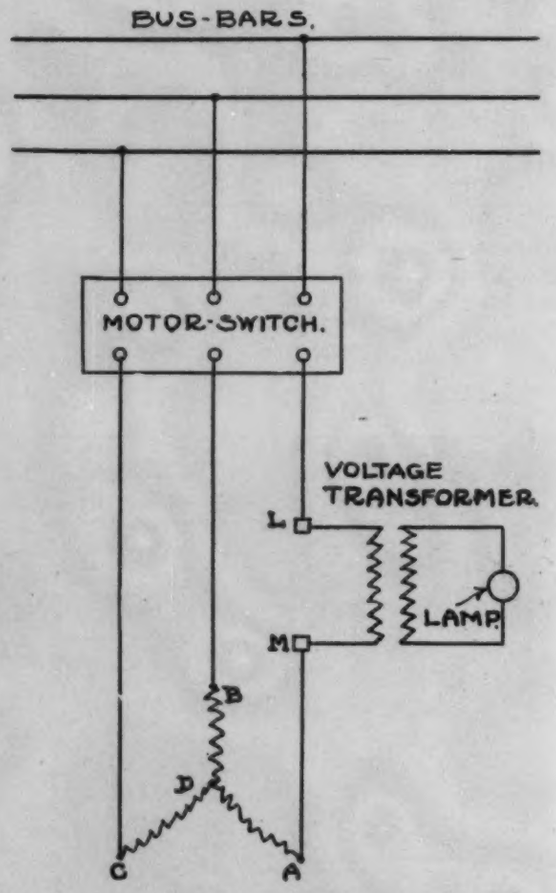


Fig. 1. Connections for Test of Three-Phase Machine.

loss of voltage during transformation and the resulting polyphase system is unsymmetrical. The voltage of the tertiary circuit with the machine running light—that is, with no load on the polyphase system or idle windings—is approximately equal to the primary voltage, but falls off rapidly with increasing polyphase output.

As the test is made with the motor running light the difference in voltage between the active and idle windings will not be sufficient to affect the results.

The method of conducting this test will now be explained, taking as an example the frequency changing set illustrated on the first page. This set is provided with a high torque starting motor having a wound rotor. The main driving motor is represented diagramatically in Fig. 1, which shows the connections for test.

First the set is brought up to approximately normal speed by the starting motor; then with the terminals of one phase open as at L-M, the main motor switch is closed. The motor will then run as a single-phase machine from the leads C-B; at the same time an electromotive force, practically equal to that of the active winding, will be induced in the idle winding between D and A.

Now if the direction of rotation is to remain unchanged with all phases connected (motor running polyphase) the instantaneous polarity of the points L and M must be such that there will be no difference

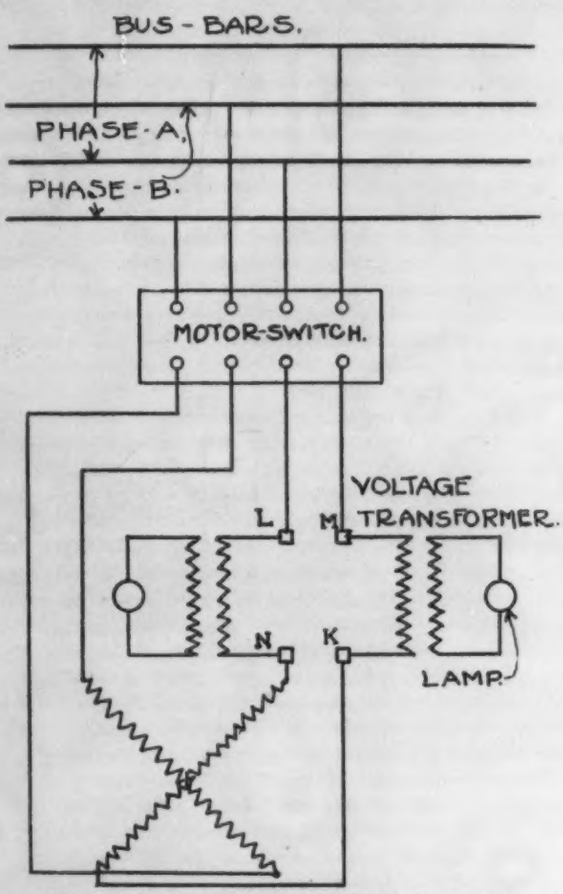


Fig. 2. Connections for Test of Two-Phase Machine.

of potential between these points. This may be conveniently determined by bridging the primary terminals of a suitable potential transformer across these points.

Hence, a lamp connected to the transformer secondary will remain dark, indicating the connections are correct to produce the direction of rotation in which the set was first started; that is, the rotation for the starting and main motors will be alike. The main switch is then opened and the lead A closed at L-M. The connections will then be correct to start the set in the regular manner and with the assurance that the main motor will not tend to reverse the rotation upon closing the main switch.

However, should the lamp burn bright, it will indicate a difference of potential across L-M and any two of the motor leads must be reversed to produce the correct rotation. It should be remembered that reversing any two leads of a three-phase motor will not effect the direction of rotation as a single-phase machine. After these changes the same test should again be made to prevent errors.

This test is applied to a two-phase equipment in be satisfactory for low voltage equipments. Again in Fig. 2 the primary leads of the transformers may be criss-crossed; that is, connected between L-K and M-N, respectively, then indicating correct connections by bright lamps. Further, for a two-phase motor only one lead of either phase need be opened, as at L-N or M-K; in which case the difference of potential will be approximately double the motor voltage for wrong connections, or about zero for the correct arrangement of leads.

Taking into consideration all of these facts, it will be apparent that the test for both synchronous and induction motors is identical after the machines are running single phase. The former, however, must be in synchronism with the system before connected, even a similar manner, except that each lead of the idle phase is opened as in Fig. 2. Two transformers with primary coils wound for the motor voltage are required. The transformer secondary and lamp voltage must also be alike. Both lamps will remain dark when motor connections are correct. If the lamps indicate wrong connections, the leads of either phase must be reversed.

However, with a three-phase motor the voltage across the terminals L-M may be twice the motor voltage, since with wrong connections the electromotive force induced in the idle phase and that of the supply circuit will be in series. Thus, a 4400-volt (primary winding) transformer will be required with a 2200-volt motor.

Transformers for double the equipment voltage are often not available. In such case transformers wound for the motor voltage will be suitable if connected only momentarily during the test, since any good potential transformer will stand double the normal voltage when applied in this manner. The condition of the lamp and transformers should always be checked by testing across one phase of the line or motor. This precaution will always eliminate a possible chance for error.

Certain modifications of these connections to produce the same results are possible. As an example, a voltmeter may be substituted for the lamp, or a number of lamps instead of a transformer and lamp will as a single-phase machine, while the induction motor need only be brought up to approximately normal speed.

A further application of these principles will explain why starting or protective devices for polyphase motors are usually equipped with only one no-voltage release attachment. Additional protection is not afforded by having a release coil across each phase, since failure of voltage on one circuit will permit the motor to run single phase and by feeding back into the idle phase will keep the no-voltage attachment from acting. In the connections for a modern auto-starter with one no-voltage release coil the usual fuses are replaced by relays which open the no-voltage coil circuit in case of overload, allowing the auto-starter switch to return to the open position.

THE INDUCTION MOTOR AND GENERATOR.

Discussion by members of the San Francisco Section of the American Institute of Electrical Engineers of paper by F. G. Baum, published in this journal November 19, 1910:

S. B. Charters: The discussion from Professor Ryan was given to me in the form of a brief abstract of points to cover, and I will go over those of which I have made record. They follow much along the lines taken by Mr. Hillebrand.

The principal places at which the non-synchronous generator is being used, and the principal places in which it is probably going to be used, are where we wish to achieve further economies in the production of power. Probably the most important application of the non-synchronous generator is in connection with the low pressure or exhaust turbine. The turbine can be connected to the exhaust of practically any type of engine, and the electrical generator can then be connected solidly to the line without having to bother with switches and circuit breakers, because the unit will pick up load in proportion to the energy which is supplied from the exhaust steam. It is, in general, practical to put in sufficient low pressure turbine capacity to double the output of your station with only a relatively small increase in boiler capacity. That of course tends to a more economical production of power. In a recent paper in the Institute Proceedings[1] in connection with the Interborough Traction System it was shown that by the use of engines and low pressure turbines driving non-synchronous generators they are realizing a thermal efficiency of 20.6 per cent, which you can see is a satisfactory figure. As I said, theoretically the generator cannot be connected in on the line without taking any precautions. Mr. Hillebrand has also pointed out that that would be the case. Mr. Waters two years ago made a number of computations from machines running at 1000 kw. and 25 cycles up through 13,000 kw. machines and 60 cycles and voltages from 2200 to 11,000. In all those cases the maximum slip required to develop full load current was only one and one-quarter per cent, whereas in the minimum case not over .4 per cent slip was required to develop full load current. That eliminates to a certain extent the supposed simplicity, because if you cannot be out more than .4 per cent at the instant of synchronizing it is going to be difficult to get a unit of that kind on the line without causing a disturbance.

The next place where you can utilize power is in connection with small hydraulic power sources. When you have a main network once established and connected up with synchronous apparatus it should be theoretically possible, as small water-powers become available, to connect them in by providing a small water wheel and a non-synchronous generator at each power source. This is only possible in the development of a synchronous network, that is, a network embodying synchronous machines. Theoretically such a plant can be left to take care of itself. Practically it may be another story when you come to do it.

There is a further factor. It has been said that the non-synchronous generator requires current from the line for excitation. In a large network it is entirely possible that the capacity of the system, even supposing all the synchronous apparatus cut free from it, may be entirely sufficient to excite the generator, and allowed to run up its voltage. For instance, the capacity of the Interborough system in New York is sufficient to charge a ten thousand kilowatt twenty-five cycle induction generator without any synchronous apparatus being connected to the line..

In case just cited if only a 2000 kw. machine had been connected in there would have been sufficient exciting current to develop twice normal voltage.

In developing such water-powers it will be necessary to design the water wheels driving such units for much higher speeds than are now regarded as practical. If you are running it as a water-wheel is normally run, there is nothing to prevent the non-synchronous generator speeding up to practically the speed of the jet, that is, about double the ordinary speed, if the synchronous apparatus be removed from the line. In Mr. Waters' paper the large amount of current taken for excitation is also discussed. The smallest case shown, that for the turbine driven alternator, requires 8.1 per cent of normal load current, whereas for the gas engine case, sixteen per cent of normal load power is taken as exciting current. That current must be furnished from the synchronous apparatus running on your lines. You are affecting your power factor to that extent. If you had a large number of non-synchronous generators you might easily use exciting current enough to take all the capacity of your synchronous machines.

A combination of synchronous converter for instance and non-synchronous generator makes a very satisfactory unit and is free from practically all the troubles which are connected up with in operating a synchronous converter and a synchronous generator. On short circuit the synchronous converter loses its voltage, and therefore the entire outfit goes dead. That point is discussed in connection with the Interborough. As conditions are in the Interborough at present, before the installation of the non-synchronous generator, they figure that on their generators for the first few cycles it should be possible theoretically to develop approximately fifteen times normal full load current, and then settle down. On their synchronous converters it was possible to develop three times the normal full load current.

If they should put in a full complement of non-synchronous generators, with the coming of a short the synchronous apparatus loses its excitation as to kill the non-synchonous apparatus. The short circuit current is then reduced to the current which can be furnished by the synchronous converters, which of course is a very different condition of affairs from the one just mentioned, only about three times normal, as stated.

Another fact brought up is this: In such a system using non-synchronous generators and synchronous converters, or synchronous generators and non-synchronous motors, on the line, the control, as far as voltage regulation goes, is entirely from the synchronous machine. You have therefore sacrificed one-half or more of your ability to control conditions on the line, because you cannot do any governing from the non-synchronous unit. The voltage regulation must be controlled entirely from the synchronous voltage. As soon as you put in a non-synchronous generator you at once lose more than half your ability to control conditions on the line, which sometimes may be a decided disadvantage.

B. C. Shipman: The difficulty of throwing in non-synchronous machines seems to be exaggerated. I first had experience with such a machine eight or nine years ago when a water-power plant was furnishing power to a street railway. They had a 1400 h.p. motor, and they converted from 6600 volts, I think it was, to 500 volts d.c. The hydraulic plant became inadequate, and the power company wanted to buy power from the street railroad, so they made arrangements to take it back through motor generator sets. It worked practically. All they had to do was to cut out the compounding, and the attendant would go in in the morning to switch his shunt motor on anything he wanted to, and the induction motor as generator delivered power all day without any trouble. They had no trouble whatever in switching.

A later case was even more evident on that point. I had occasion to put in the plant. It was a 1200 kw. turbine unit, non-synchronous generator, and a 1200 kw. rotary. They used the current for electrolytic refining of copper. The voltage was 220. We used to throw those together without difficulty. There were three-section knife blade switches, and I think the current was somewhere around 1600 amperes per terminal, something of that kind. We had no difficulty in throwing them in

[1] The Non-Synchronous Generator in Central Stations and Other Work. W. S. Waters, Proc. A. I. E. E., 1908.

and took no precautions. The combination was put together without a bit of trouble; never had any trouble from it at all. So I think, if you could handle a 1200 kw. that easily, there would not be much difficulty in handling 5000.

A point in connection with that, but which has not been taken up at all, is the fact that the non-synchronous machine would counteract to a certain extent the rise of potential on the lines. It takes a lagging current to excite, and it would balance out the capacity to a certain extent.

If you had non-synchronous generators at the generating end, and rotaries at the receiving end, they would serve as very valuable regulating means, especially if these were used in connection with some automatic system of regulation. I know I have seen transmission systems, where the regulator kept the voltage absolutely uniform at the receiving end, and it changed all around at the power end. In fact the power-house, if it is any distance off, has very little to do with the voltage at the receiving end. They can't control it at all. So on the basis of the regulation it seems to me that the case against the non-synchronous generator is not strong.

P. M. Downing: From a theoretical standpoint this paper is interesting and no doubt to a man with the knowledge and ability of my good friend Baum its preparation is a mere matter of relaxation and pastime, but to those of us who have to do more with the practical operation of the apparatus, the theory becomes a harder problem.

The action of the induction motor is too well known to require any discussion. The field of the non-synchronous or induction generator has been discussed this evening, and what I say will have reference more particularly to its use in connection with large transmission networks.

It has been brought out by each of the three speakers thus far that this type of machine has a wide field in connection with taking care of the capacity current incident to long transmission lines of high voltages.

If you can conceive of a transmission system having no load or one with a large synchronous motor load and the motors operated with fields over-excited, then you might have a condition where the induction generator would serve a useful purpose. As a matter of fact this condition does not exist and for that reason the induction generator has never been used for the purpose mentioned by the previous speakers.

The commercial load as handled by any long distance transmission system is made up to a very great extent of induction motors and is, therefore, of low power factor. Every induction motor and every induction generator that you put on that system takes additional wattless current, which is the greatest bugaboo with which the transmission engineer has to contend The lagging current more than offsets the leading current due to the capacity of the line and to such an extent that it is common practice to install synchronous generator capacity much in excess of the actual kilowatt load to be carried, in order to handle the wattless current due to the low power factor.

I can readily see where an induction generator will serve a useful purpose in a station, such as that of the Interborough Company in New York, where there are large units of power with little inductive resistance in the line between units, but with a network where the generating stations are far removed from each other, I am unable to see where the induction generator could be used to advantage..

In the early days of long transmission on the Pacific Coast it was thought that troubles from high voltage, such as have been mentioned by the previous speakers, would be experienced. To keep this voltage down, or in other words, to neutralize the capacity current, reactance coils were installed, but it was soon found that they were unnecessary, and were never used except for experimental purposes.

At the present time the company with which I am associated is putting in a synchronous condenser to take care of this wattless current. It might also be interesting to note that the synchronous condenser is being installed in the identical station in which the reactance coils were originally placed, in fact the reactance coils had to be moved out of place to make room for the synchronous condenser.

The conditions being as I have stated them, I can hardly see where there is any field for an induction generator on a hydro-electric network supplied with power from generating stations at considerable distances from each other.

B. C. Shipman- All cases are not networks. Sometimes you have to generate your power at one place and transmit it as a whole to other places, and there you may use it for other purposes than induction motors, so in that case your induction current would be quite a serious matter for handling.

P. M. Downing: I would consider that a special case. The discussion this evening has all been along the line of general networks. Where power is generated at one point and transmitted as a whole to another, the conditions are somewhat different as you would no longer have the network.

I do not think the matter of first cost should be the determining factor. Continuity of service must be given first consideration, and with the difficulties which have been brought out and which are apt to arise when synchronizing the non-synchronous machines with your transmission line, it seems to me that after all the simplicity of the induction generator is not a very great recommendation for its use.

S. J. Lisberger: What Mr. Downing says is absolutely correct. I wish Mr. Varney were here tonight to tell you of some changes that he is making in San Francisco in his department. He is re-winding some 1000 kw. motor generator sets where the motors are now taking current at 11,000 volts. Those motors are being rewound for synchronous operation instead of induction. I asked him just what his saving was in efficiency, he replied he did not have his figures with him, but recalled offhand that at full load the 1000 kw. set as induction motors took about 62 or 63 amperes; with synchronous machines it dropped down to about 51 amperes.

P. M. Downing: Better still if he would take 62 amperes leading current.

L. R. Jorgensen: If I should say anything it would be much of a repetition of what Mr. Downing and others have just said. The most important installation of induction generators today is as far as I know the installation of the Interborough Rapid Transit Co. This installation seems to be successful, but there are in this particular case several favorable conditions which make this kind of generator particularly adaptable. First, this station works in parallel with other big stations; therefore the current rush during a short may be very heavy with many synchronous machines feeding this short circuit. With induction generators this would not be the case. Then also this station feeds a large cable network, and the condenser effect from the cables may be able to neutralize the magnetizing current drawn by the induction generators, so that after all the lagging current introduced into the system by the induction generator is not a disadvantage. If the station capacity in synchronous generators is twice or more the capacity in induction generators, the effect of this lagging current is not so pronounced.

On our water-power systems in the West it is not so necessary to keep down the amount of power in synchronous apparatus, even if they feed the same system, for the reason that the reactance of the long interconnecting line will prevent a rush of current greater than the switching apparatus can take care of, and we seldom have leading current to spare. For small stations connected to a large system however, the induction generator should be of advantage in greatly simplifying the station and attendance, that is, if the system can stand the lagging current introduced.

For medium sized steam plants I see advantage in their use only if the power factor of the load is close to unity, and especially if leading, which it seldom is on a loaded system.

So far as synchronizing is concerned I do not see so much difficulty in that, especially if the reciprocating engine and low pressure turbine are started at the same time, the induction generator will run as a motor a little below speed at the time the synchronous generator is ready to throw on the line the speed of the induction generator will be but little below synchronous, and little trouble should be experienced. We could also have a little steam in the turbine to help out. After the synchronous machine was on the line full speed could be put on the turbine to make the induction generator run above speed and take load.

S. J. Lisberger: I think the conditions on the Interborough system would have been different if they had a 60 cycle system. The probabilities are they would not have rotaries such as they have, and the induction generator would not have been such a long felt want in this particular case.

I would like to ask some of the maufacturing gentlemen what is the difference in price per kilowatt. Does anybody happen to know the difference in price per kilowatt of the two units?

W. W. Briggs: I don't think there is any data on that. I think the price per pound is about the same.

S. B. Charters: I believe in the discussion of Mr. Waters' paper in 1907 that point was taken up. I believe the point has been made that it is a much cheaper installation. They make the point that you eliminate all your exciting apparatus, your apparatus for synchronizing, and you can operate your engine without a governor except for over-speeds. Figuring all that in I believe they arrive at the conclusion that the non-synchronous generator should be much cheaper in proportion to install, but I don't think anybody gave any actual figures on it.

I agree with Mr. Jorgensen that the paper points out the disadvantage of throwing the machines on the line at the speed corresponding to maximum torque. It says if the machine is thrown on at lower speed the desired result would be obtained. Now is it not a fact that if the induction generator or motor, as the case may be, is thrown on to the line at low speed, of course there won't be the maximum torque at that point; but as the machine comes up to speed, when it does attain the speed corresponding to the maximum torque, that the torque will occur at that point? Isn't that just as bad as if it were thrown on the line at that point, and how would that be overcome? You could not overcome having that high torque when the machine came up to speed unless you decreased the voltage. That would introduce another complication into the system.

Mr. Baglor: One thing I did not understand as being brought out in the paper, that is, will this improve the power factor on the line? I understand this is going to put leading current into the line from the induction generator. It will not improve the power any?

S. J. Lisberger: No, on the contrary, it will decrease, because it takes a lagging current from the system.

A. H. Halloran: The discussion this evening has had a tendency to get away from Mr. Baum's theoretical treatment, into a more practical—and perhaps a more useful one. Mr. Baum's idea is to explain by the graphical method the action of induction machines, first of a transformer, then of an induction motor, and finally of an induction generator. When this graphical method is understood, the analytical method of Steinmetz will be clearer. There are some men that can think in mathematics and the calculus, just as some can think in German, or in the metric system without need of converting into English words or into English units; but the great majority of us want a picture. That is what Mr. Baum has given.

Carrying the pictorial method one step further, there are many men that cannot even follow the mathematics, simple as it is claimed to be, in Mr. Baum's paper, and require some simpler conception of what an induction generator is. I remember seeing a great 20-mule team hauling oil in the mountains. There were two fast horses at the head of the team. They stepped along lively and set the pace for the rest. Those horses would be just as good if driving a light buggy on Sunday as they were pulling this heavy team on Monday. But they are likely to run away; they get excited, and commence see-sawing back and forth on a steep grade and may lose the load entirely, while on the down grade they are likely to run away. They require some steadying influence that will pull harder on the up grade and hold back on the down. This is provided by the wheelers, who work well in tandem but are too slow and heavy to be driven alone, being mere machines giving power to the machine, but not concerned with the speed.

A little thought will show that the synchronous generator corresponds closely to the leaders in this 20-mule team, and that the induction generator corresponds closely to the wheelers. The induction generator gives current only when connected to a synchronous machine and has no independent voltage. It feeds power into the machine but does not participate in the regulation. The synchronous generator supplies a large amperage on a short circuit, thus being like the leaders on a down grade, but the induction machine ceases to generate when short circuited.

POLES PURCHASED LAST YEAR.

The total number of poles reported to the Bureau of the Census as purchased during the calendar year 1909 by the telegraph and telephone companies, steam and electric railroads, and electric light and power companies of the United States was 3,739,000, as against 3,249,000 in 1908 and 3,283,000 in 1907. There were purchased in 1909 by the same class of users 3,509,000 cross-arms, 6,168,000 brackets, and 18,463,000 insulator pins. Cross-arms, brackets, and insulator pins were not included in the annual census of lumber and timber products prior to 1909.

This information appears in a preliminary comparative report covering 1909, 1908, and 1907, which has been transmitted to Census Director Durand by Chief Statistician William M. Steuart, under whose supervision it was prepared by J. E. Whelchel, expert special agent of the Division of Manufactures. In co-operation with the Forest Service of the Department of Agriculture, the Bureau of the Census annually collects and publishes statistics pertaining to the group of lumber and timber industries.

Telephone and telegraph companies reported purchases during 1909 of 2,916,000 poles, or 78 per cent of the total. This was an increase over 1908 in the number reported as bought by this class of users of 354,000 poles, or 14 per cent, and over 1907 of 604,000 poles, or 26 per cent. Steam railroads reported the purchase of 26 per cent more poles in 1909 than in 1908, though 34 per cent less than in 1907, while the reported purchases by electric railroads and electric light and power companies were 18 per cent greater than in 1908 and 7 per cent less than in 1907.

There was little change in the average cost per pole of all lengths and from all species of wood in 1909, as compared with 1908, it being $1.89 in the later and $1.82 in the earlier year. The average cost per pole, $2.46, in 1907, was substantially larger than in either of the later years, mainly for the reason that a class of pole consumers in the United States which uses chiefly short poles was not included in the census for 1907.

Of the total outlay during 1909, $1,621,000, for cross-arms, brackets, and insulator pins, the telegraph and telephone companies contributed 63 per cent, electric railroads and electric light and power companies 32 per cent, and steam railroads 4 per cent.

EXPERIENCES PACIFIC COAST GAS ASSOCIATION.

EDITED BY LEON B. JONES.

A Service "Check."

The local printing office and publisher of one of the daily papers, sent in a no-gas complaint. Upon investigating, the gas at the meter inlet was good. The outlet was opened to see if the meter was stuck, but instead of finding the cause to be such, the brass-check (under separate cover) was found reposing in the connection.

The editor of the paper was consulted to determine the object of the thing. He stated, that the Gem gas bill reducer, cost him $3.50 and was a protection to prevent what gas passed through the meter once from again running back to the main, when gas was not in use by the house. He, the editor, fully believed this to be a fact, and stated that the confidence man (from whom he purchased the bill-reducer) showed him testimonials from a number of publishers as to the ability of the check.

The trouble man suggested to the editor that he place a few brick-bats on the meter and tie a wet sack about it, and maybe he would reduce the gas bill.

A Box of Gas.

Some while ago a family moved in town from a farm. They had not been accustomed to the use of such necessities of life as gas.

They were persuaded to use gas, as connections were in the house they moved into. For the first month or so they got on very well, the quantity of gas used was above the average; until one month the gas used did not equal the meter charges. This fact was noted by the bookkeeper, and thinking that something might be wrong with the meter, ordered it to be changed.

When the man reached the house with the new meter, a woman greeted him with: "Well! I thought it about time that you brought around another box of gas."

How the Leakage Was Quickly Reduced from 45 to 7 Per Cent.

"Once upon a time," so began many of the fairy stories of our infancy, but this is an account of an actual occurrence —the writer was invited to take charge of an Eastern gas works, where the alleged discrepancy between make and accounted for gas had all at once started to climb from 10 to 40 and 45 per cent and for several months had stuck to the higher figures.

The president of the company was an old ex-soldier and had threatened to do something desperate to himself unless the trouble was soon located.

The superintendent, then quite a young man, and now one of the best general managers in the business, said the president was welcome to act on his own suggestion; but as for himself, having done all he could to find the trouble unsuccessfully, he was willing to let some one else try his hand.

The writer, for the first month of his second incumbency of that position (for ten years prior to the above, he had been in charge of the same plant, and had partly rebuilt it), let things go their natural gait, but watched all closely; and found everything working well. But at the end of the month the unaccounted for gas loomed up 45 per cent just the same.

The station meter showed a certain amount of gas had passed through and had been duly recorded. Coal and water gas was being made and with a large stock of material on hand, for it was winter, the checking up same was not so easy.

But if 45 per cent of gas leaked away, some odor should have been perceptible somewhere. We had been barring the street mains for leaks, finding a few unimportant ones which were repaired. Where could all this gas have gone to? The station meter had been tested and found correct. The gas holders, three of them, were reasonably tight. And just at that point the writer began to suspect something. Toward the end of his first engagement with that company the manufacture of water gas had been introduced. But that was at a time when the relief holder was not yet known, and when we had only two holders, which were connected with a 12-in. valved main, so that No. 1 holder could be filled from holder No. 2, which was the heavier. In the following years during which the writer was at a western works, holder No. 1 was made the relief holder for the water gas apparatus, and a third storage holder was added.

There were three or four changes in the superintendency also, and the connection between holders No. 1 and 2 was forgotten, or overlooked(for I had left a good ground plan of the works when going west in 1883). It occurred to me to look up that main and valve and found it to be both accessible and surprisingly easy to operate for a valve supposed to have been so many years out of use. I jammed that valve fast with a crowbar, filled in the hole on top of it myself, said not a word to anybody about it, and the next month our leakage had been reduced to less than seven per cent.

As a sequel to the preceding narrative the following may be interesting. Soon after discovering the cause of the supposed enormous leakage, and stopping same, it was found that more coal and oil was used (apparently) than either the quantity or quality of gas made warranted.

The carbonizing sheets showed the usual number of runs made, as well as all other data corresponding; but while the candle-power grew no better the quantity of gas was less.

So I procured a recording pressure gauge, connected it with the relief holder inlet, and found the trouble inside of twenty-four hours. The night gas-maker did not make any gas from about two until 5 a. m.

This could be clearly seen beyond room for doubt upon the pressure gauge registry card which would—as you all understand—show a decided increase in pressure whenever a new run was started in the apparatus.

It was a surprised gas-maker, when the next morning he was told by the writer of this undeniable dereliction of duty; and that, with the former discovery, caused the cessation of further attempts to find out if or not "the old man" knew his business; especially as it was told the working force in impressive, if unprintable, language what the consequences would be "the next time."

How a Process Was Born, or "Necessity Is the Mother of Invention."

In July, 1883, the writer was appointed engineer and superintendent of the Laclede Gas Company, of St. Louis, Mo., and found the following conditions:

The city was divided into two gas districts. South of Washington avenue was supplied by the "St. Louis Gas. Co.", and the price of gas was $2.50 per thousand cubic feet. The district north of the avenue named was furnished with gas by two companies; the first and older being the "Laclede Gas Company," and the other, or oppositon, was known as the "Light, Heat and Power Company of St. Louis."

The works of the latter company were located in the old St. Louis Gas Company's district (occupying part of the ground now used as the Union Station), but sold gas only in the Laclede's district, charging $1.00 per thousand cubic feet; the Laclede Gas Company's price being limited by law to $1.50 per thousand. Coal gas was made by the first two and water gas by the latter of the companies named; which was started strictly as an opposition to the Laclede. The "Light, Heat and Power Company" in canvassing for business not only used the reduction in price as an argument, but asserted—to convince subscribers that they would not afterwards raise—that water gas was naturally just as good as coal gas; while it could be made ever so much cheaper "because it

was largely made from water or steam which cost very little." The situation was beginning to look serious to the Laclede officials when the writer was called and placed in charge by the president of the company. Under then prevailing local conditions it was seen that coal gas was by far the cheaper to produce, notwithstanding the specious logic employed by the opposition company to get consumers, and in which they were quite successful.

The water gas company were operating the Lowe process, and we could not get a license to use this. Other methods to produce water gas were offered, looked into and declined, because they appeared to be palpable infringements of the fundamental Lowe patents.

So then the writer decided to invent a process which would at least enable us to also manufacture water gas—if we wanted to—and thus meet the arguments of our opponents, "fighting the devil with fire," as it were. The method decided upon was to use a cupola somewhat like the so-called "Springer process," which by the way owed its successful operation to the remodeling by the writer one year before at Chicago, for in its original form it was a dismal failure. Then, instead of using a blower and air pressure to bring the fuel to incandescence in the generator, we employed an exhauster and drew the necessary air through the fuel bed; and thus the "suction gas process" was born. It is true we made only blue water gas in the generator, but we did it with a notably smaller expenditure of fuel than was done in the air blast machines. The gas was carbureted with oil gas made by a simple but effective method in our ordinary coal gas retorts; and after a few improvements made to the original apparatus, we found that we had a pretty good water gas process, which fully served our purpose as previously indicated. We then likewise reduced the price of gas to $1.00 per thousand cubic feet. Our canvassers could tell our patrons that we also were making water gas, which we did, too; about one-third of our make being such; and we fought our opponents to a standstill in a little while.

A "Near" Asphyxiation.

A most unusual accident (as well as a very humorous one to all except the victim) occurred in Los Angeles a few weeks ago.

While a captive balloon, inflated with ordinary illuminating gas and being operated at Eighth and Broadway, was preparing for an ascent, one of the men in charge attempted to smooth out some wrinkles near the top of the balloon by climbing up the rigging between it and the gas bag. Just before reaching the top he stopped to rest, and in doing so allowed too much of his weight to press against the well filled bag, causing it to rip. Of course the imprisoned gas immediately rushed out, tearing the slit larger as it issued forth. The man clung to the network of ropes like a fly to a wall until overcome by the escaping gas, when he dropped and disappeared through the hole in the balloon.

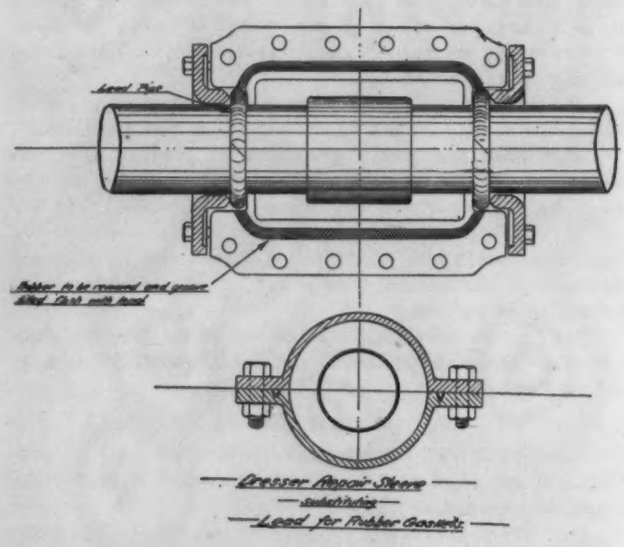
There were several eye witnesses of the accident, and it required only a few seconds to cut a hole in the bottom of the bag and allow the unfortunate victim to drop out. A cool-headed individual who happened to be near, immediately secured an oxygen tank, the contents of which, together with other restoratives, were administered to the unconscious man. After about forty-five minutes of strenuous work, including artificial respiration and the rolling of the victim over a barrel, he regained consciousness. He was at first somewhat delirious, but in a very short time was well and sound again, and able to assist in repairing and refilling the balloon.

Centrifugal Pumps.

It may not be generally known that the head or pressure against which a centrifugal pump will work can be raised or lowered by a change in the design of the runner, with no other alteration. We recently had occasion to change a pump designed to pump against 15 lb. per square inch, to work against 40 lb. This was done by simply changing the runner, at a small cost, and the pump is perfectly satisfactory.

Experience With High Pressure Joints.

We have considerable trouble on a 10-in. high pressure line, which is casing connected with Dresser couplings used with rubber gaskets. No cooler is used except the storage



tank, and consequently the gas is sent out very hot. This heat expanded the joints to such an extent that the benzol in the gas had a chance to act on the rubbers with a result that the rubber, after softening up, finally blew out of the joint and leaked. We had these repair sleeves on hand. They are the standard heavy repair sleeve of the Dresser type intended to enclose a Dresser coupling, and they are made up with rubber gaskets. As we found the rubber gaskets would not last under these conditions, we decided to try lead in place of the rubber. The rubber in the split sleeve itself was pulled out of the crevice and this run even full with lead. We then used some standard ⅜ lead pipe, cut two lengths sufficient to make a gasket with a diagonal joint, as shown, and used these in place of the regular rubber gasket. We had no trouble in pulling up this repair sleeve complete and gas tight, and they have given us no further trouble.

Use of Dresser Couplings for Emergency Repairs.

For some time we have used Dresser couplings for our high pressure gas lines about the works with great satisfaction. A while ago we had a break in an important hot oil line, and by the use of these couplings it was put back into service in a very few minutes, while to install a flange coupling would have necessitated cutting several threads and consumed a half hour or more.

Now we keep all sizes of these couplings on hand for such work and they have saved us from trouble several times. We have used them on steam, water, hot oil, compressed air, and, in fact, all kinds of connections, and find them perfectly satisfactory for emergencies. When we have the opportunity we then replace them with permanent construction.

We have one 4 in. coupling on a hot oil line which carries 100 pounds pressure. It has been in place three months and shows no sign of giving away. This is being carefully watched to see if these couplings can be used as permanent connections.

A Method of Handling Purifying Material.

The writer's experience in handling purifying material, particularly where the purifying boxes are scattered around different portions of the gas works, may be of interest.

The particular experience in question was gathered while operating the gas works at St. Louis, Missouri. At the various gas plants in St. Louis there were a number of sets of outdoor purifiers situated in different portions of the gas works and generally of steel cylindrical construction, more or less of the cheese box type, and these boxes were as high at the edge as 16 in. in some instances. There were openings on top of these boxes some 5 ft. in diameter and also openings on the sides large enough for a man to wheel the material in which a wheel barrow upon temporary wooden staging erected for that purpose.

The largest of these boxes were 40 ft. in diameter by 16 in. in depth at edge, and owing to the considerable number of these boxes and the scattered location of same, a mechanical contrivance for easily and economically putting fresh purifying material into them became a necessity as well as an interesting study.

The cost of filling these large purifiers was considerable. The plan finally adopted was to construct a simple portable bucket elevator made up of two iron channels long enough to reach from the ground to well above the boxes. A belt carrying the buckets ran between these channels over proper wheels at both ends and at the top discharged into a spout which might be turned in any desired direction.

At the bottom of the machine a simple steel frame work carried an electric motor which was used to operate the bucket elevator. A small steel hopper at the bottom completed the features of this equipment.

The whole contrivance was mounted on wide flanged iron wheels so that two men could readily push it around the yard and up to any of the purifiers it was desired to fill. Electric wires with convenient sockets were installed near each set of purifiers so that rapid connection to the motor could be made at any desired location.

The operation of the machine was simple. The man wheeled the fresh oxide up to the hopper by means of a small runway and dumped same into it. The bucket elevator hoisted the oxide and discharged it by means of the spout into the portions of the boxes.

The entire outfit cost comparatively little money and effected a great saving in the cost of filling these purifiers, and as the same was portable, it could be used almost anywhere where electric wires could be run.

It occurred to the writer that inasmuch as a great many purifiers in California were out of doors owing to the wonderful climate of the Pacific Coast, that such a device might become useful to some of the members of the Pacific Coast Gas Association. In the writer's experience the machine was found equally satisfactory when used in-doors, and as it was pushed around on wheels, it was easily possible to bring it into any ordinary purifying house through a large door.

An Experience With Automobile Head Lighting With Blau Gas.

Blau gas is an ingenious result of the compression of oil gas to 1500 lb. per square inch into a liquid form. This liquid is then expanded into gas at a pressure of 25 lb. per square inch, and then reduced to 12 in. water pressure by the use of the ordinary high pressure regulator.

The writer had the privilege of being present at the first test of this new illuminant for automobile lighting. A flat landaulet was fitted with a small steel bottle of liquid Blau gas containing about 2 lb. of the liquid. One pound of Blau gas expands into about twelve cu. ft. of the illuminating gas and a pound of the liquid will supply a 60 c.p. incandescent light for about 17 hours. The steel bottle and expansion tank occupied but small space and were fastened to the running board in a manner similar to the Presto-light. The gas was led to the headlights through small copper tubing and was applied directly to inverted incandescent mantle lamps which had previously been used for alcohol vapor. These were the best to be obtained and were but poor expedients. The party left Long Island City, making wide detours over the roads of Long Island to Long Beach, returning to New York City by way of the Williamsburg bridge to the Hotel Manhattan, a distance of 65 miles in four hours' time.

The lamps were lighted at Long Island City, and remained lighted during the entire trip with the single exception of a few minutes when the gas was shut off by the motion of the car shutting the gas valve.

The trip was made over the roughest roads imaginable and with little hope of success, but at the end of the journey the mantles were uninjured and the illumination was exceptionally good as the Blau gas heated the mantle to full incandescence, and the light was entirely without shadows on account of the use of invert mantles.

This experience was novel as it demonstrated the safety of transporting and using liquid Blau gas with rough handling.

DISCUSSION OF PAPERS AT EIGHTEENTH ANNUAL CONVENTION PACIFIC COAST GAS ASSOCIATION.

"Municipal Inspection of Gas and Gas Meters."

Mr. Clements: Mr. President, I enjoyed Mr. Schade's paper very much indeed. It comes within my province and general routine to meet the public almost every day for some complaint, and I know how they feel toward that little instrument—the gas meter. As I said in a paper which I read before the Association, I think at the last session, I called upon an eminent gentleman in the city where I live, who made this remark, "That gas meter of ours seems to have a sort of intuition to help you people at the time when you need money." "Now," he says, "this is the month of December. This is the closing of the financial fiscal year. Why, all around in this neighborhood among all my friends, I find the bills have been increased. Why do they do it? Evidently to assist the company or the officers of the company to make a good showing to the directors and increase the percentage of income—in other words to pay their annual dividends." Coming from a gentleman of the type he was, it seemed ridiculous, and of course, I thought he looked upon it as a joke, but pinning him down he actually felt quite earnest about it. He thought that the meter could do just about like it wanted to.

But I find there is one feature about the gas meter that does not seem to work exactly right, and that is, it so often overlooks that people have gone away on vacations, and while they were not using any gas the meter kept on recording. That is one thing about the gas meter I think we should correct, and I hope the City Inspector will look to that for the benefit of the company.

Thaddeus Lowe: I thoroughly believe in municipal inspection of both gas and gas meters, but I do not believe that municipal bodies should have the authority to say anything as to the quality of the gas. I believe that companies should be allowed to sell any quality of gas they choose, and make a price in accordance therewith. I believe the future gas will be one that has low candle-power, and which can be sold to the consumer at a much lower cost. I believe it is more or less municipal interference to regulate the quality of gas. I believe that as far as municipal inspection relates to the quality it is entirely wrong, and that municipalities should establish a price based on quality, and allow the gas company to sell any quality of gas they choose, as a merchant would sell any quality of wares he chooses. I think this is an important point, because today the municipalities regulate the quality which we must live up to, and it does not give us an opportunity to develop along the lines of low quality at a less price.

President: If you do sell a lower quality of gas I think they would have to take some means to determine the quality supplied.

Thaddeus Lowe: Oh, yes.

President: That would necessitate the employment of the city inspector still.

Thaddeus Lowe: Oh, yes.

Mr. Britton: Having been guilty for a great many years of imposing these instruments upon the public, I am strongly an advocate of Mr. Schade's position. People, in masses, are like children—they need a governing hand. The corporation that seeks to govern the people by its own rules and regulations is looked upon naturally, with suspicion, but anything today that is instituted by the government, whether municipal, state or national, is looked upon by the masses of the people in a favorable light, as a God sent Savior to save them from the sins of the corporation, and you can always make more by running with a crowd than you can by running against the crowd, and I believe today is a period of time when the corporations should run with the crowd, and the crowd is greatly tending toward the regulation of corporations, especially public service corporations. But behind that all it seems to me there is a question of justice there, even as against municipal inspection, and that is the personal attitude of the corporation to the consumer. I think in California today we need more municipal inspection in every city, because by that we gain what we cannot obtain in any other way—publicity. Through municipal bureaus the actions of public corporations will be discussed. Unfortunately the corporation side is seldom given space, but the argument against is given full space. I have never known a case where municipal requirements as to heat units, candlepower and general quality of gas did not serve to quiet ninety per cent of the disturbing element in the public and for the reason, as I said before, that they have absolute confidence in the officers of the municipalities, appointed for the service, who are, as a rule, disinterested men seeking to follow out the dictates of the law appointing them. I have not met one inspector who has not been ready to listen to the side of the corporation, and give it all of justice that is due it. Now the time is past in the history of corporations when we can "Vanderbiltize," so to speak, the public—that time has past. The type of corporations that are co-operating with the consumers do more toward rendering municipal inspection unnecessary than any laws we may seek to pass in our own business.

Mr. Newbert: The question of municipal inspection of gas and gas meters is one that I have given a great deal of thought for some time. In fact, I have read a great number of reports of State commissions and associations. In the larger cities like San Francisco and Los Angeles, where the municipality provides an inspector, the companies, I consider, are fortunate. However, in the smaller city, like most of us have to deal with, we have no municipal gas inspectors, nor will those small cities go to the expense of providing a municipal gas inspector. Therefore the whole question resolves itself into what was brought up in this morning's session of having in this State a commission similar to the commission in Massachusetts, Wisconsin and New York. The public service corporations of this State would be subject to the rules of the State commission instead of the rules and regulations of municipalities.

Mr. Schade: Mr. President, members of the Association. I would gladly and cheerfully agree with you if I knew where I would come out. I would not like to be in the position of the Irishman who got hit with a brick, and turned his case over to a lawyer to have him fight it, and sue for a recovery. So after he recovered he notified the Irishman to come to his office, and the lawyer handed him $50. The lawyer said, "Here is your damages." "Well, he says, "that is $50; how much did you collect?" "Well," he says, "including your damages and the costs, $500.00." "And I get $50.?" Say, he says, "which of us two fellows got hit with the brick?"

Now, Mr. President, I would like to make two statements. I don't want to cast any reflections on anyone, but there are two points to be considered—one is with regard to what Mr. Lowe spoke of, that is, as to the quality and the amount of heat units the gas should carry. One thing is, you all know if it wasn't for the awful, awful reputation that the gas companies have in all respects, it would be all right, but you can't convince the people that you are giving them a square deal in this generation. Another thing is I am satisfied that the councils that have municipal gas inspection in hand have made real investigations, and ascertained from competent men just what can be done in that line, and I believe the gas companies are just as well off with municipal gas inspection as without it, though, in supplying different kinds or qualities of gas as Mr. Lowe spoke of, for instance where there are more companies in a city than one, and they make gas of 750 or 680, etc.—now, how are you going to do this—who is going to get the cheapest gas? They are not going to have pipe lines all over where people can jump over. No, the good gas comes on one corner and the cheap gas on another. Now, there will be a free-for-all fight there in a minute. I believe the municipalities as well as the State and representatives—that they thoroughly investigate the matter. To show you the methods, a letter was received at my office from the State Librarian of New York, making inquiries and asking for a report, and he said it was for the benefit of the State Senators and the State Public Utility Commission, so you see they are sparing no means to make an impartial investigation everywhere. I had another letter from Washington, D. C. They are trying to give everyone a fair and square deal.

E. P. Lowe: Mr. Schade hits the nail nicely on the head when he tells us that the gas company needs the municipal inspector to tell the public it is honest. We are all selfish; it is human nature to be selfish. We know nothing about the golden rule, save in theory; between individuals we may practice it but between the general public and the gas companies it needs the recognized servant of the people to teach them the honesty of the gas company. It is the best and cheapest way to teach, and if we had to pay the gas inspector ourselves we would better do it.

Mr. Schade: I wish to say for the benefit of the gas manufacturers here that they need not fear municipal gas inspection. It is for the benefit of the corporations and the individuals both, and I think I can say that without prejudice or partiality. I believe I have done more work in Los Angeles since I have been in office than the company could have done with one hundred men taking my place on the outside. The gas companies are a thousand times more honest than the public ever was. The consumer likes to get just a couple of feet for nothing, but they are not willing to pay one cent more than they ought to. One lady whose meter was closely correct called me in, and after talking to me says: "Say, Mr. Inspector, would you fix my meter a little slower?" I said: "I have not authority. You called me over here to give you a square deal. You would not believe the company's man. Now you ask me to fix your meter slower. If I did what kind of a fix would I be in? It would not be two hours before your next door neighbor would know that I fixed your meter.

Thaddeus Lowe: I don't want you to think for one moment I am against any meter inspection; we need it. I am perfectly satisfied with our experience. In Pasadena I think there have been four meters tested under their ordinance, and in every instance it was in favor of the consumer. The consumer has to pay for inspection and we have not had any trouble since.

Mr. Schade: During the last winter I had more than 350 calls from people wanting their meters inspected. I don't think I inspected one out of twenty-five, because when I go there and ask them the trouble, I usually find out that the meter is all right, and I would give them instructions as to how to use the gas and the appliances, etc., and tell them, "Now, try for another month, and if you are not satified at the end of this month, let me know and if the meter is wrong; if you were charged more than

you should pay—I will see that you get your money back, whatever the amount may be, because it is a physical impossibility for a meter to increase its record without more gas going through."

"Suburban Distribution."

Mr. Jones: Gentlemen, Mr. Newbert has had a large and successful experience in the distribution of high pressure gas on the peninsula south of San Francisco. One of the ambitions of my life is about to be realized, in the construction of a steel bracelet around the city of San Francisco for feeding the low pressure system. This main is now in the ground and is sixteen inches in diameter; a heavy steel tube joined together by rubber gasket joints, and the length of the main is 7½ miles. It extends from the old Potrero gas works, almost around the city to the old plant we call the North Beach Station. In the construction of this pipe line, we tried to profit by our former experiences, both in the coating of the steel pipe, and the joining of the pipes together. You will remember in a paper read some years ago, it was thought that red lead, properly ground in oil, was the best protective you could get for a steel pipe. We afterwards found that there was a granulation of the lead, which would take place after it had been in the ground for a considerable time, leaving the pipe exposed. After that we put on a second coat, an outer protective coat of good metalic paint, to protect the red lead. This worked fairly well, but was not entirely satisfactory. In casting about for a good coat for this new sixteen-inch main, which is, as you all know, very expensive and hard to repair, we found a substance consisting of coal tar pitch. This coal tar product was brought from Australia. First the pipe is cleaned, then a thin coat is applied with a brush. This first coat seems to amalgamate with the small particles of rust that may be on the pipe, and gives the first coat a good grip to the pipe. Then we take an enamel and apply it boiling hot, at a temperature of something like 300 degrees Fahrenheit; this will cling closely to the pipe, and has no tendency to peel off. We enamel the pipe to a thickness averaging one-eighth of an inch. Before using the enamel we tested carefully to see that it was free from acid or alkali, and also tested its insulating qualities against electricity, and we don't anticipate any trouble from electrolysis on the new line. We have had some trouble with the use of rubber gaskets in making joints, due, I presume, to the solubility of rubber in the presence of the hydro-carbons of oil gas. The benzol has a tendency to soften and destroy the rubber next to the pipe, to such an extent that the flanges at the joints become loosened and cause slight leaks. In order to prevent the gas from coming in contact with the rubber gaskets we apply a coat of orange shellac dissolved in alcohol to the V shaped space between the sleeve and the gasket and next to the pipe, and on one surface of the rubber gasket, so that there is no actual contact between the gas and rubber. The gas comes in contact with the coat of shellac, and we hope that this will prevent the disastrous effect of benzol on the rubber gaskets. This line was laid by Mr. W. R. Morgan, our able superintendent of distribution.

To show you how we have advanced in the laying of high pressure mains. This pipe line is not yet in use for conveying gas, on account of construction work now going on. This main has been under pressure, under 60 pounds pressure for over 30 days, and it has maintained a constant pressure at uniform temperatures both day and night.

Mr. Newbert: I would like to ask if soft lead has ever been tried in the gasket, in the place of rubber?

Mr. Jones: We were able to try a gasket on the Petaluma line, which is one and eight-tenths inches internal diameter, and sixteen and eight-tenths miles long. We found rubber gaskets would soften, and we were casting about for some other expedient, something that would answer the purpose and make the joints tight, and Mr. Weber, manager of the Petaluma plant, suggested the use of soft lead wire, in place of rubber gaskets. Under Mr. Weber's direction and entirely due to his ingenuity, that entire line was supplied with soft lead gaskets, and is tight so far as we know.

"Fire Insurance and Protection."

Mr. Britton: I am sorry Mr. Cantrell is not here. He was appointed some three or four years ago, as insurance agent for the Pacific Gas & Electric Company. His duties are to trace up the causes of fires and make recommendations as to how we can best prevent them. Our territory covers 30,000 square miles and has in it, all types and characters of buildings and structures, and he has made periodical visits to every station and every office, and if he has accomplished nothing else, from my observation as I followed in his tracks, he had drawn to our attention, the value of cleanliness on the part of the employe. He has caused offices to be cleaned out; he has caused walls to be whitewashed, broken windows to be replaced, and has caused the removal of inflammable articles to places where they would be least likely to catch fire. He has awakened a spirit in every employe of the company, looking toward cleanliness, and I can see a very marked improvement in the plants. And I sometimes think that I can trace, in the analysis of the weekly and monthly report that we get, a tendency toward economy, due to the greater interest taken in the care of the plant, instanced by this periodical inspection. His salary has been earned over and over again and many a disastrous fire which might have occurred has been prevented by his recommendations, and in that way he saved us thousands of dollars.

Mr. Leach: In regard to that Mr. President, I would like to say that a spontaneous combustion fire was created in this way. If it had been in yard where it occurred, we would probably have lost one of our large warehouses, but it occurred in the bin as a result of Mr. Cantrell's visit. Saturday afternoon as the men were cleaning up, the foreman of that department found some oily matter in one of the rooms and insisted upon having it put in the bin. Sunday evening the fire department was playing the hose on the bin.

I feel that this question of fires should be looked at entirely without prejudice. Very often the carelessness of property owners adjacent to our own property, scattered about the various cities, causes us more loss than the carelessness of our own employes, or any lack of fire appliance that we might have. In the larger cities the fire department are more or less of a political nature. A good many individuals are permitted to have gasoline lamps and gasoline stoves in their buildings and oil furnaces are not carefully looked after, all of which causes destructive fires; and if it is a large building it is more apt to have this trouble and these fires frequently result in a great loss to the gas and electric companies.

I think the time will come when the fire fighting will be done by a corporation, created and organized for that purpose, and that fire fighting is just as much of a business as gas and electric lighting is a business. I think some means should be taken, something should be started, that would create a public approval of putting all fire fighting in the State, under the entire supervision of the fire underwriters, and taken out of politics entirely.

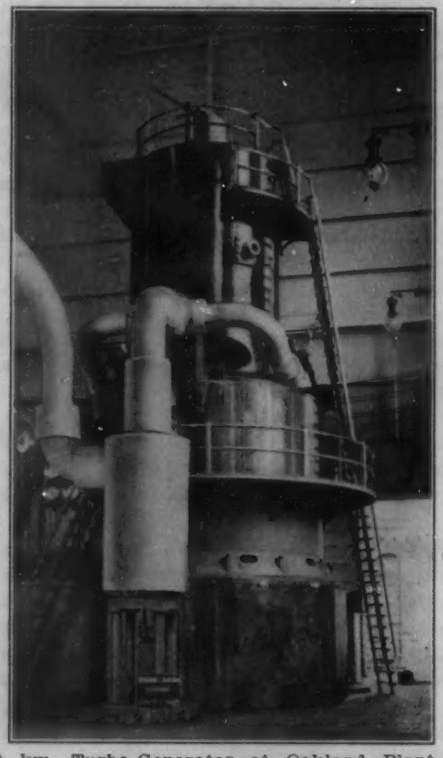
Mr. Schade: I would like to say that a friend of mine has gotten up a simple patent for handling gasoline, oil, or any combustible with water. About two weeks ago some parties got hold of it and organized a two-million dollar company, and refused to have any display made at this time. It is a most valuable thing for an oil man to own, and install. Instead of pumping oil with it, you pump water. It is absolutely fireproof; you can build a fire over it, under it, or around it, and it won't catch fire.

Mr. Jones: For the benefit of Mr. Schade I would like to say, that a device used for the same purpose as stated by him, has been in use by gas companies for the last twenty years.

Mr. Schade: I thank Mr. Jones very much. I know there have been in use such devices, but not like this one.

TURBO GENERATOR TESTS.

At the annual meeting of the American Society of Mechanical Engineers in New York City on December 7, 1910, two papers were presented dealing with tests of large steam turbine units operated under



9000 kw. Turbo-Generator at Oakland Plant of Pacific Gas & Electric Company.

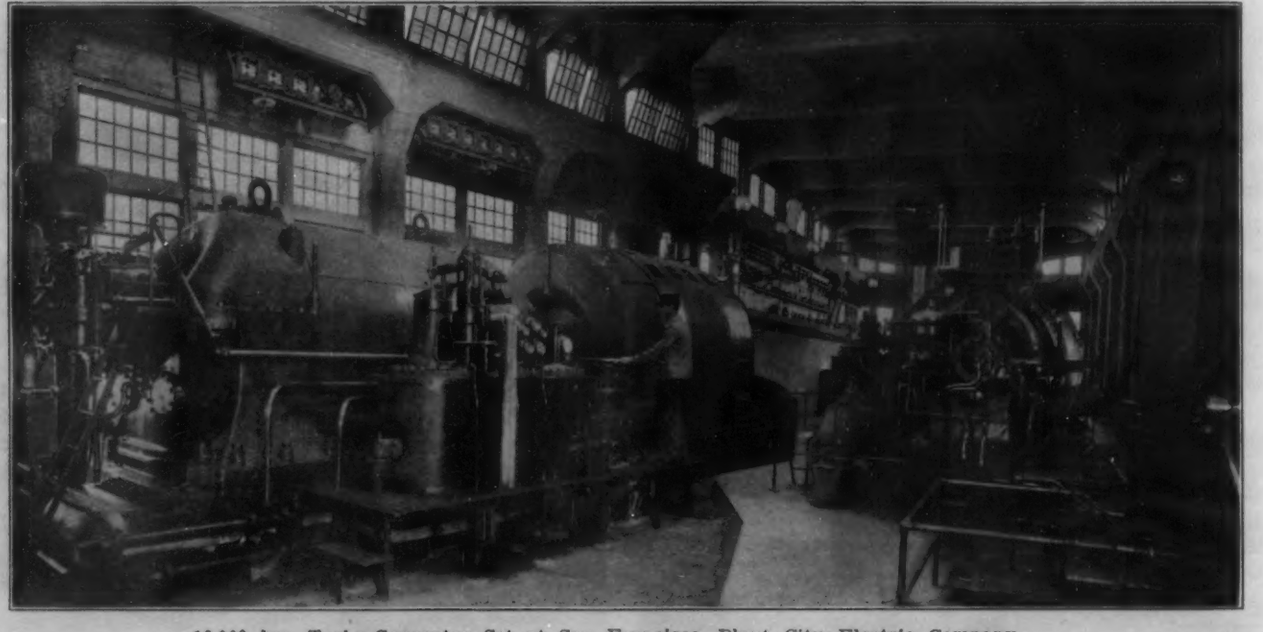
Pacific Coast conditions. H. Varney's paper considered the tests of the 9000 kw. Curtis vertical turbine in the Oakland plant of the Pacific Gas & Electric Company illustrated and described in this journal of March 5, 1910. S. L. Naphtaly's paper was concerned with tests of a 10,000 kw. Westinghouse-Parsons horizontal turbo-generator in the San Francisco plant of the City Electric Company, described in these columns on August 20, 1910.

In each case the tests were made under operating loads to verify the builders' guarantees. Both plants are oil-burning, supplying steam at 175 lb. gauge and equipped with super-heaters for 100 degrees superheat.

The Oakland turbine was subjected to two four-hour tests, under loads of 7000 kw. and 9000 kw. respectively. The final result for the 7000 kw. test was a steam consumption of 16.06 lb. per kw. hour without correction, or 15.82 lb. under the corrected conditions specified in the contract. Under the 9000 kw. load the uncorrected steam consumption was 15.95 lb. and the corrected 15.42 lb. per kilowatt hour. The corrected vacuum was 28 in. Steam was furnished by eight 754 h.p. McNaul water-tube boilers. The condenser and vacuum pumps were of Worthington make.

Seven tests were made in the City Electric Company's turbine, varying from 1.5 to 4 hours in duration. Correcting to 175 lb. pressure and 100 degrees superheat, 28 in. vacuum, the steam consumption in lb. per kw. hour was 14.11 for 7972 kw. load, 13.88 for 8563 kw., 14.04 for 8198 kw., 13.88 for 9173 kw., 15.21 for 5333 kw., 1407 for 8148 kw. and 15.24 for 5401 kw., the last two being with a low vacuum (26.16 lb) to determine the effect of variation in vacuum on this machine. Steam is supplied by Babcock and Wilcox boilers. Auxiliary apparatus included Wheeler condensers and pumps.

Electrical dispersion of fogs is being studied by Sir Oliver Lodge, particularly with reference to sea-ports. He suggests that the British Government should allot one-half million dollars annually to universities carrying on these experiments.



10,000 kw. Turbo-Generator Set at San Francisco Plant City Electric Company.

VALUATION OF PUBLIC UTILITIES.

The valuation of public service corporation property was recently discussed by H. E. Riggs at a meeting of the American Society of Civil Engineers Mr. Riggs stated that the industrial and economic development of the past two decades has opened many new lines of special work in the profession of engineering, none of which is more difficult and complicated or of greater ultimate value to the public at large than that of the appraisal or valuation of the property owned and operated by public service corporations; and none of the fields of engineering specialization requires greater care or calls for more skill, experience, integrity, or sound judgment.

Valuations may be required either as a matter of public interest, such as to give information on the taxation of corporations, rate regulation, limitation of capitalization, or for franchise purposes; or it may be a matter of corporation necessity or expediency.

A valuation, regardless of the purpose for which made, should be such as to secure a "fair value" of the property under consideration. Appraisers will encounter, among other difficulties, the fact that human selfishness is a dominant quality, and that attempts are sometimes made to influence a valuation from selfish motives; also that human machines are not exact duplicates, and that allowance must be made for a large measure of error, on account of the personal equation of the men engaged on the work, as individual errors of judgment are frequent on any work of magnitude. This personal element must be corrected by uniformity of method, by constant checking, and, as far as possible, by subordination of personality to system.

All properties being appraised should be considered as operating properties. One which is dead, inert, and not in use, cannot be considered as coming under such a discussion as this, and such properties are not treated in this paper. The term "going concern" is not used in connection with the physical property, any element of value implied by the term, over and above the "overhead charges," being treated as intangible or non-physical element of value.

Explanation of Terms.

In order that there may be no doubt as to the exact meaning of the terms used throughout this paper, a few definitions or explanations are submitted:

Appraisal, or Valuation.—These words are used interchangeably, and refer to the engineering work of determining the present worth of both physical and intangible properties of corporations.

Cost of Reproduction.—This expression refers to the estimate of cost of reproducing the physical properties as they exist on the date of the appraisal, all elements entering into the cost being considered as new and not affected by the elements of depreciation or obsolescence.

Cost, or Original Cost.—These terms refer to the actual amount of money paid for the property, either when it was originally constructed, or in its condition at the time of appraisal, the latter case being the original cost plus the cost of additions and betterments, less abandoned, replaced, or worn-out property. This figure ought to be represented by the "book cost," but it is not often that "book cost" and "actual cost" are the same.

Present Value, or Present Physical Value.—These terms are used in describing the physical property as reproduced after it is affected by all elements of depreciation or appreciation. The use of the word "value" in this expression is unfortunate, as it may lead to some confusion. It must be kept clearly in mind that, where this term is used, it refers only to physical property as depreciated, and is in no case intended to refer to the final or "fair" value of the property.

Non-physical, or Intangible, Value.—These terms are used to represent those elements, entering into the final worth of the property as a business concern, which arise out of the operation of the property and are not attachable to the physical property.

What is "value?" In defining the exact meaning of this term, as applied to the property of a public service corporation, a number of elements must be taken into account. Standard authorities give many definitions of the term. As a definition of that estimate of worth which an engineering commission should report as the result of a complete appraisal, the writer submits the following:

The value of a property is its estimated worth at a given time, measured in money, taking into account all the elements which add to its usefulness or desirability as a business or profit-earning proposition.

There are two classes of elements entering into the final value:

(1) The "Physical" Property Element of Value.—This consists of those things which are visible and tangible, which are capable of being inventoried, their cost of reproduction determined, and their depreciation measured. The property is considered as an operating entity, and, being so considered, carries as part of the physical value, those costs and charges which are an inseparable part of the cost of construction but do not appear in the inventory of the completed property.

(2) The "Non-Physical" or "Intangible" Elements of Value.—These are those things which, added to or taken from the worth of the physical property, make up the value, and include whatever accrues to the property by reason of its operation, or by reason of grants, contract rights, competition, or location, which at the time of appraisal affect favorably or unfavorably the worth of the property.

The physical property is that which enables the corporation to do business. Without physical property it could not produce the commodity which it sells. The amount of money actually invested in acquiring that physical property represents the measure of capital on which it is morally entitled to earn interest and profit; and, in the stage of promoting and financing the enterprise, all hope of earnings is based on the amount of money required to construct the property. These considerations lead the writer to contend that the true method of valuing a corporate property is first to determine the cost of reproduction of the property and its depreciation, and modify this figure by any applicable positive or negative non-physical elements of value.

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Changes of advertising copy should reach this office *ten days in advance of date of issue.* New advertisements will be accepted up to noon of Monday dated Saturday of the same week. Where proof is to be returned for approval, Eastern advertisers should mail copy at least thirty days in advance of date of issue.

Entered as second-class matter at the San Francisco Post Office as "The Electrical Journal," July 1895.
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FOUNDED 1887 AS THE
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Public Satisfaction Corporations

The good-will of the people is seldom reckoned as an asset in appraising a public utility, though its absence is a recognized liability. It is perhaps the most intangible of all those non-physical values accruing from the possession of franchises, monopoly, or demand for service. Though at one time the most easily obtained, it has frequently been so carelessly disregarded that it is now as hard to regain as is the spurned love of a woman. Many managers have already awakened to this fact and there were few meetings of electric light and power associations this year at which this question was not discussed. Many of their papers on cultivating friendly relations with the public have been published in these columns, but, judging from personal experience, their spirit and intent has not been transmitted to the rank and file who come in most intimate contact with the people that the corporation is endeavoring to serve.

Every employee of every public service company should realize that he is the personal representative of his company, and often the only one by whom his employer is judged. His incivility and lack of accommodation prejudices patrons and depreciates public estimation. Nothing is more irritating than the pompous assumption of superiority of a petty government clerk who forgets that he is being paid by the people whom he displeases. The same spirit seemingly pervades many workers for these quasi-public utility companies whose prosperity is even more vitally dependent upon public favor. If all employees would unite in trying to satisfy the public, their company, instead of being a public dissatisfaction whose stock is almost unsalable, would become a public satisfaction corporation whose position would be almost unassailable.

To satisfy the people that the corporations are giving good service at reasonable rates is the prime object of the public service commissions that have been established in Massachusetts, New York, Wisconsin, New Jersey, Vermont, Connecticut and Maryland. In these states regulation is proving to be good for the people and better for the corporation because it establishes a friendly feeling of confidence. Other states will soon follow suit. The movement is as gradual but irresistible as that of a glacier. In states where the corporations have been rapacious the laws will be radical, but where they have been conciliatory the legislation will be conservative.

It consequently behooves every corporation to seek the public favor. Why talk of cultivating friendly relations when it is possible to be a friendly relation to every consumer? An occasional "Dutch uncle" talk from the manager of the lighting company will convince his fellow-townsmen that he is their friend and that they should become his. The power and influence of a corporation in the capacity of a big brother can help every community. If this friendly feeling be not established, there is a further possibility that the relations will be reversed, and that a paternal government will assume not only regulation but also operation.

PERSONALS.

Rudolph W. Van Norden is doing some engineering work in Eldorado county, California.

L. Work, an electrical supply dealer of Monterey, was a San Francisco visitor last week.

F. G. Baum, of F. G. Baum & Co., electrical engineers, has returned from Santa Barbara to San Francisco.

A. W. Smith and A. F. Smith of the Sacramento Valley Power Company, visited San Francisco this week.

Leon Bly, secretary of the Sierra Electric Power Company of Red Bluff, was at San Francisco last week.

R. M. Morton, engineer of the Highways Commission of San Joaquin county, spent last Monday at San Francisco.

W. S. Heger, the California manager of the Allis-Chalmers Company, spent the past week at his Los Angeles office.

Thomas Mirk, of Hunt, Mirk & Co., returned to San Francisco last Monday from a business trip to San Diego.

H. R. Noack, manager of Pierson, Roeding & Co., recently returned to San Francisco after a business trip through Oregon.

J. L. Stannard and A. L. Richardson have opened offices as civil and hydraulic engineers in the Henry Building, Portland, Ore.

H. W. Jacobs of Santa Rosa, and D. W. Thomas of Petaluma, were among the electrical supply dealers at San Francisco last week.

H. L. Jackman, manager of the Humboldt Gas & Electric Company of Eureka, was a San Francisco visitor during the past week.

C. W. Curtis has been appointed general foreman of the Los Angeles & Redondo Railway, Los Angeles, Cal., in charge of the power department.

C. P. Baird, manager of the Lompoc Light & Power Company, of Lompoc, arrived at San Francisco last Saturday, accompanied by his bride.

L. O. Lieber has resigned as electrical engineer of the Los Angeles & Redondo Railway, Los Angeles, Cal., and the position has been abolished.

Chas. Derleth has been elected president and James H. Wise vice-president of the San Francisco branch of the American Society of Civil Engineers.

John M. Gardiner, who is interested in electric power and railway plants in Southern California, was at San Francisco from Los Angeles during the past week.

Samuel Taylor, manager of the Electric Railway & Manufacturers' Supply Company, has returned to San Francisco after making an extensive Eastern trip.

H. C. Goldrick, Pacific Coast manager of the Kellogg Switchboard & Supply Company, of Chicago, spent the past week on a tour of the Pacific Northwest.

Delos A. Chappell of the Hydroelectric Company of Bodie, returned to the power site last week, after spending some time at San Francisco in conference with his principals.

C. W. Burkett, general superintendent of plant with headquarters at the San Francisco office of the Pacific Telephone & Telegraph Company, has been at New York for several weeks past.

L. L. Johnson, formerly gas engineer for the electrical department of the Southern Pacific Co. at San Francisco, has opened an office as consulting engineer on gas, power and fuel plants at Indianapolis, Ind.

Robert Howes has completed the installation of the Fraser Valley line of the British Columbia Electric Railway Company and has opened offices as consulting engineer in the American Bank Building, Seattle.

Leon M. Hall, the former chief engineer of the Comstock Pumping Association, was recently presented with an elegant gold watch as a token of the esteem in which he is held by the employees of the mines at Virginia City.

C. E. Groesbeck, Pacific Coast manager of the H. M. Byllesby Company, with headquarters at Portland, arrived at San Francisco last Monday on business connected with the taking over of electric power plants purchased by the Byllesby interests.

E. G. Dewald, with the Pelton Water Wheel Company, has returned to the San Francisco office from Big Bend, where he started a Pelton oil-pressure governor, which had just been installed to regulate the large water-wheels of the Great Western Power Company's big transmission plant.

H. Y. Liang, a prominent Oriental engineer, has been spending several weeks at San Francisco getting important data for use in connection with industrial enterprises for the Chinese government. He recently visited the oil fields of California. Liang has made his local headquarters with Smith, Emery & Co.

TRADE NOTES.

The General Electric Company has sold to Cady & Bunnell, of Susanville, a 150 kw., 6600-v., 600 r.p.m water wheel driven generator, together with a 5-kw. exciter set and a switchboard.

The Northwest Oil Burner & Equipment Company has been organized by W. F. Ross and A. G. Starrock with offices in the Couch Building, Portland, Ore. They are the sole agents for the Hammel Oil Burner Company of Los Angeles.

MEETING NOTICES.

The Seattle Section of the American Institute of Electrical Engineers at their meeting on December 17th, listened to a paper on the subject of "Continuity of Service," by Magnus T. Crawford of the Seattle-Tacoma Power Company.

The Los Angeles Section of the American Institute of Electrical Engineers will meet at Blanchard Hall, 231 South Broadway, at 8 p. m., on December 29th. Prof. R. W. Sorensen will present a paper on "Transformers and Their Selection.'

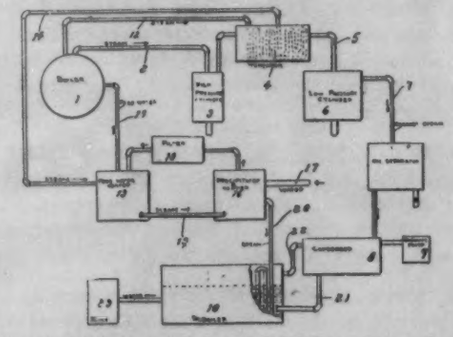
The Engineers' Club of Oregon was organized on December 7 at Portland. George L. Bliven was elected chairman and A. D. Monteith secretary. A strong membership committee was organized and vigorous efforts will be made to induce all engineers to join.

The San Francisco Section of the American Institute of Electrical Engineers will not meet on December 30th, on account of the probable absence of many members during the Christmas and New Year period. Prof. Ryan will discuss Atmospheric Electricity at the meeting of January 28, 1911.

The annual convention of the American Institute of Architects will be held at San Francisco, January 17-19, 1911. Papers to be read include "The Development of Architecture on the Pacific Coast," "The Rehabilitation of the City of San Francisco," "The Aesthetic Problems of and what the Coast has Accomplished in City Planning," "The Salient Points of the Architecture of the Northern Pacific Coast," "History and Present Status of the California Missions."

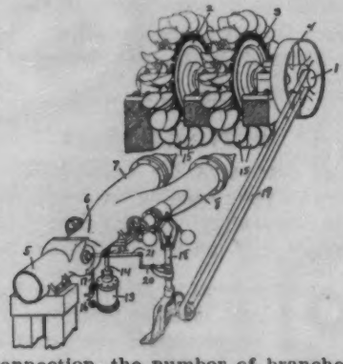
PATENTS

978,279, Distillation System for Ice Plants. Arthur Faget, San Francisco, Cal., assignor to Pacific Engineering Company, San Francisco, Cal. In a water distillation system, a steam boiler, a steam power plant, steam connections from



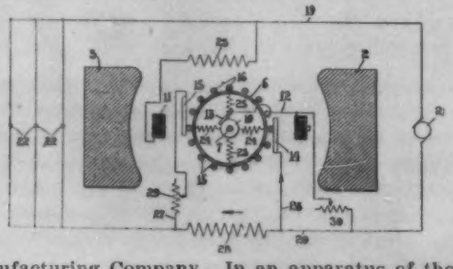
the boiler whereby the steam used in the power plant may be reheated during its passage therethrough, a feed-water heater and steam connections from the reheater to the feed water heater, whereby the live steam passing through the reheater will heat the feed water nearly to that of the boiler, as set forth.

987,335. Water-Wheel. Arnold Pfau, Milwaukee, Wis., assignor to Allis-Chalmers Company, Milwaukee, Wis. The combination with a shaft, of a plurality of water jet actuatable wheels thereon, a pipe for supplying water to said wheels, a branched nozzle hinged to said pipe at a single connection with the hinge axis at an angle to the pipe conduit at the



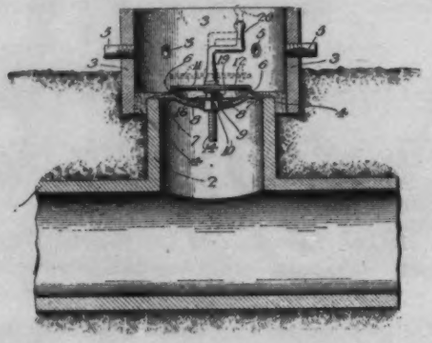
single hinge connection, the number of branches of said nozzle corresponding to the number of wheels upon said shaft, each of said branches being provided with a valve for controlling the flow of water therethrough, a governor responsive to the changes of speed of said shaft, and a single regulating means controlled by said governor for raising and lowering said branched nozzle.

978,518. Electrical Measuring Instrument. Thomas W. Varley, New York, N. Y., assignor to Westinghouse Electric



and Manufacturing Company. In an apparatus of the character described, a substantially constant magnet, a coil adapted to shift or distort the field caused by said magnet, an armature in said field, adapted to respond to the shifting or distorting thereof, and having more than one connection to one side of the main circuit, a resistance in said main circuit between said connections, an adjustable resistance in one of said connections, a resistance across the armature adapted to collect current from different points thereof, and means for taking off current from said last named resistance at a point intermediate the ends thereof.

978,567. Irrigation-Valve. James M. Eads and Arthur S. Bent, Los Angeles, Cal. An irrigation valve comprising a ring forming a valve seat and having a flange cast integrally therewith, a downwardly bowed yoke extending across the ring and being cast integrally therewith, said yoke having a square, tapered orifice formed therein, a brass, square, tapered nut in the orifice in the yoke, the small end of the nut being



headed over to secure it in position, an adjusting screw in said nut, said screw having a shoulder, a round portion below the shoulder and a square portion below said round portion, a valve disk below said shoulder, a gasket below the valve disk, said valve disk and said gasket being on said round portion of the screw, a square sleeve with a round flange below the gasket and supporting the same and being mounted on said squared portion of the adjusting screw, a set screw securing said sleeve to the squared portion, and a crank formed on the upper end of the screw.

978,805. Switch Mechanism. Charles D. Weimer, Los Angeles, Cal. A switch mechanism comprising a plurality of stationary contacts, a movable contact, means to move said movable contact in engagement with said stationary contacts, means to hold movable contact in engagement with said

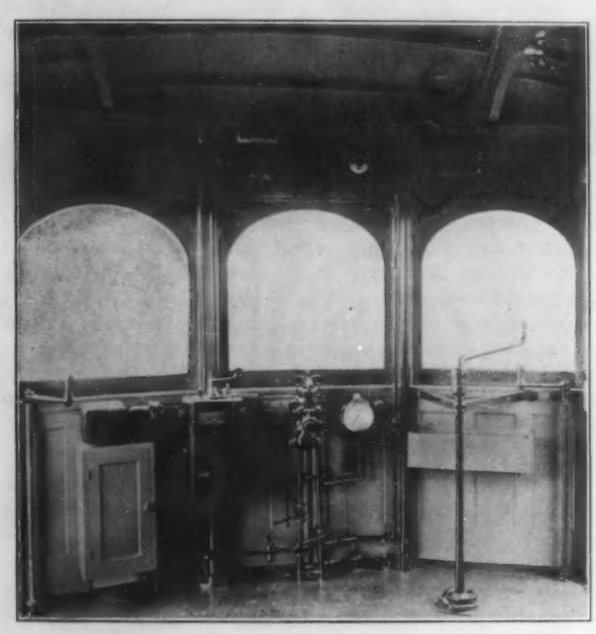
stationary contacts, and a means to disengage said moving means and said holding means from said movable contact to leave said movable contact free to return to normal position and out of engagement with said stationary contacts

INDUSTRIAL

NEW MOTOR CAR EQUIPMENT FOR PEORIA RAILWAY TERMINAL COMPANY.

The Peoria Railway Terminal Company has recently added five new, double truck passenger cars to its rolling stock. This company operates a standard gauge interurban electric line, connecting Peoria, Bartonville, South Bartonville, Hollis and Pekin. The new cars which are 57 feet over-all and which when fully loaded weigh approximately forty tons, are of the single end type. The car bodies complete with truck were built by the McGuire, Cummins Manufacturing Company. The trucks are equipped with 36 in. wheels mounted on 6 in. axles with 7 in. gear fit arranged for a gear ratio of 18.69. It is expected that when operating on normal schedule the single trip will include six stops in the interurban districts and an average of six or seven in the 2.8 miles of city running.

The new car is fitted with a quadruple equipment consisting of four No 304-A interpole railway motors, each motor having a nominal rating of 75 h.p. at 500 volts or 90 h.p. at



Motorman's Station in New Motor Car.

600 volts. All the important characteristics which through long tests of service have won favorable recognition wherever they have been introduced are embodied in these motors—split frames, separate oil gauging reservoirs, waste packed bearings, detachable bearing housing with provision for holding the armature in normal position while lower half of frame is dropped for examination, strap wound coils for field and armature, two-point gear case suspension and superior workmanship throughout.

The well known Westinghouse hand-operated unit switch control is used on each car. The line switches and each unit of the control switch is actuated by air under pressure of 70 lb. per square inch. The only current flowing through the master controller is the small amount required to energize the electro-magnetically operated needle valve which admits air to the air cylinders of the switch. The switch jaws are brought together with a positiveness and intimacy of contact impossible to attain with any solenoid operated contactors in which the contact pressure is of necessity a function of the line voltage. With the electro-pneumatic control a uniform reliability of operation is assured independent of fluctuations of line voltage. It can be used without risk of injury under conditions where the excessive current resulting from low line voltage would result in seriously burning or welding the contacts of any other type of switch. Both the motors and control were made by the Westinghouse Electric & Manufacturing Company.

A CABLE FORMING BOARD.

In order to make it easier for the electrical contractor who has had no experience installing inter-communicating telephones, to install their inter-phones in an up-to-date manner, the Western Electric Company is furnishing full sized diagrams of cable forming boards. These diagrams enable the contractor to make cable forming boards for every variety of inter-phone sets.

The advantage of forming the cable is apparent to all those experienced in telephone work, but until recently its importance was not realized by the electrical contractor. Experience has shown that the best plan to follow in cabling an interior telephone system is to form the cable at each telephone set so that each conductor or pair of conductors

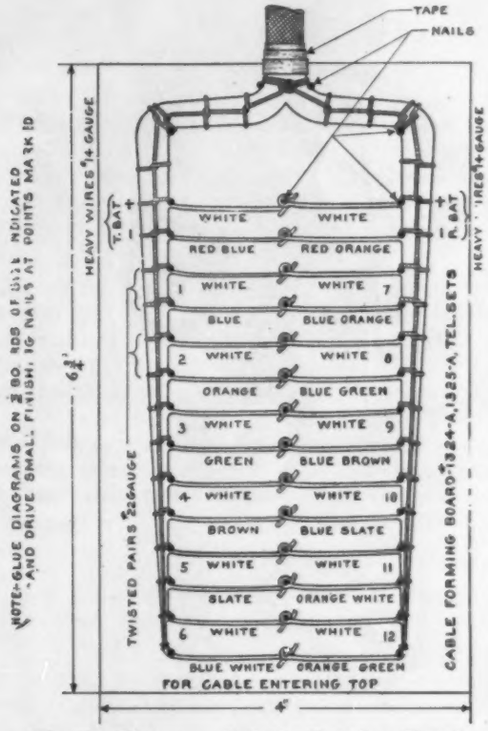


Fig. 1. Diagram of Cable Forming Board.

will be separated from the rest and sewed permanently into their respective places by the means of extra stout twine made especially for the purpose. In this way every conductor is brought out of the cable at its proper place and there can be no disarrangement of the conductors due to later handling. This reduces to a minimum the likelihood of the conductors being crossed.

Fig. 1 shows a cut of a diagram; this diagram, as furnished, is first glued upon a board about one-half an inch thick and then the board is sawed along the edges of the

diagram. This makes the board of the proper size for the different types of telephones noted on the diagram. At the points marked, small nails are driven into the board and wires are formed around the nails and sewed into place as indicated on the diagram.

A completely formed cable, sewed as it should be, is illustrated in Fig. 2. The proper twine used for the purpose is twelve strand linen, as this provides sufficient strength for allowing the stitches to be drawn up extremely tight without the chance of breaking the twine. When the cable is completed, it is lifted off the forming board and is then of the proper size, so that the conductors come out of the proper places to attach directly to the correct terminals in the telephone sets.

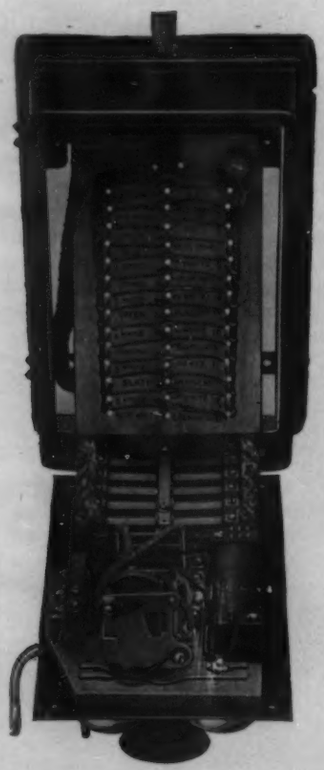


Fig. 2. Cable Entering Top of Set Has Been Formed.

The use of these forming boards insures the continued satisfactory operation of an inter-phone system, as there is little chance of the apparatus itself getting out of order when properly installed.

NEW CATALOGUES.

Bulletin 1501 describing Allis-Chalmers Reliance Belted Corliss Engines has been reprinted by the Allis-Chalmers Co.

Automatic voltage regulators for direct current generators are described in bulletin No. 4602-B from the General Electric Company.

The General Electric Company has recently issued a new edition of its bulletin on Watthour Meters for Switchboard Service, the number of which is 4662-A.

The Electric Controller and Manufacturing Company has issued an interesting booklet of facts about lighting magnets; graphically illustrating some superior constructional details of E. C. & M. K. magnets.

Bulletin No. 8 from the Benjamin Electric Manufacturing Company, is concerned with Special Fixtures and Accessories for Mazda-Tungsten Lamps. These include reflector sockets, street lighting fixtures and multiple and series sockets for large base lamps.

Bulletin No. 4794 was recently issued by the General Electric Company, describing the 1200-volt lines of the Milwaukee Electric Railway and Light Company. This is a reprint of an article which appeared in the Electric Railway Journal.

The Westinghouse Diary for 1911, a handsome red-leather pocket book, contains much new data on electrical machinery, steam turbines and incandescent lamps not published in former issues of this valuable annual. Considerable irrelevant matter has also been omitted.

The Standard Underground Cable Company have issued a valuable booklet on Colonial Copper Clad Wire which consists of a steel core to which a copper covering is firmly welded, thus giving a conductor of low resistance, great tensile strength and elasticity and an exposed service not affected by the weather, all at a comparatively low cost.

Bulletin No. 4786, just issued by the General Electric Company under the title of "Signals, Auxiliary Apparatus and Materials," describes a simple and reliable motor signal having a signal mechanism suitable for either two or three position operation in either the upper or the lower quadrant. This standard mechanism is also applicable to either top or bottom mast operation with but slight modifications. The bulletin contains nearly 90 pages of information, including exterior and interior views of the signal and a detailed description of the signal and apparatus used in connection with its operation.

"California for the Tourist" is the subject of a beautiful book just published by the Southern Pacific. By picture and text it portrays the charm of this land of sunshine by summit, sea and shore. The front cover shows a native daughter culling golden California poppies close to the blue waters of the Santa Barbara channel overlooked by the old Spanish mission of that name, the back cover shows a Sierra lake and snow covered mountain viewed from an observation car—all in the most exquisite colors. Localities illustrated include San Francisco and its environs, the Klamath country and Crater Lake, the Shasta region, Lake Tahoe, Yosemite Valley, the Kings and Kern rivers, Monterey Bay, Santa Barbara, Los Angeles and San Diego, good maps of each district being provided.

The General Electric Company has recently issued Bulletin No. 4790, on Electric Mine Locomotives, which supersedes its previous bulletin on the same subject. This bulletin illustrates and describes in considerable detail two and three-motor mine locomotives of various capacities, arranged to operate either singly or in tandem. The bulletin describes also the company's gathering locomotive, which consists of any one of its standard locomotives equipped with a motor-operated reel, to which is attached flexible heavy insulated cable. These gathering locomotives can, therefore, be operated for some distance beyond the terminal of the trolley wire by merely slipping a hook fastened to one end of the cable over the trolley wire. The reel operates automatically, and the locomotive is operated in the same manner as when the trolley is used. This publication also describes the various devices, such as controllers, fuse blocks, headlights, etc., with which the locomotives are equipped.

PORTLAND OFFICE OF PIERSON, ROEDING & CO.

Pierson, Roeding & Co. have established offices at 707 Spalding Bldg., Portland, Ore., under the management of S. H. Lanyon. Offices are also maintained in the Coleman Bldg., Seattle; the Monadnock Bldg., San Francisco, and the Pacific Electric Bldg., Los Angeles. Pierson, Roeding & Co. are Pacific Coast representatives of the Electric Storage Battery Co., Lombard Governor Co., Locke Insulator Mfg. Co., Aluminum Company of America, Ohio Brass Co., J. G. Brill Co., Fibre Conduit Co., R. D. Nuttall Co., and Bridgport Brass Co.

NEWS NOTES

NEW INCORPORATIONS.

SAN FRANCISCO, CAL.—The Sierra Incandescent Lamp Company has been incorporated by E. H. Fosdick, W. H. Taylor and C. A. Barhydt with a capital stock of $50,000.

SAN FRANCISCO, CAL.—The Sacramento Valley Power Company has been incorporated by A. Armstrong, H. E. Willis, D. Righetti, Grant Cordrey, F. V. Vollmer, L. Sutter and E. Maytorena with a capital stock of $2,000,000.

JACKSON, CAL.—The Amador Mines, Power & Water Company has been incorporated here. The new company will soon build a storage reservoir covering 150 acres of land near Pine Grove, ten miles from here, the capacity of which will be 4,000,000,000 gallons.

SAN FRANCISCO, CAL.—The Pine Mountain Water Company has been incorporated here. Its authorized capital is $3,000,000, the directors being Duncan McDuffie, C. L. Cory, W. T. Vincent, Jr., and W. C. Crud, all of Berkeley, and C. G. Dall of San Francisco. The articles authorize the concern to sell water for any purpose in any part of the State.

FRESNO, CAL.—The Vineland Telephone Company has been incorporated with $25,000 capital stock in 1000 shares and with J. C. Ashlin, Willfred Baker, R. S. Elliott, P. H. Carlsgard and N. O. P. Syonground as the directors. Subscribed capital stock is $1725 by 59 subscribers. The corporation will erect a telephone line for the accommodation of farmers in the Kerman district from the town to and beyond the river. The main line will cover 6½ miles from the southeast corner of Section 12, 14-18 in a northerly direction to the northeast corner of SE¼ of Section 12, 13-17. It will have eight branch lines in as many directions covering ten miles more to nearby ranch subscribers.

FINANCIAL.

MONROVIA, Cal.—The City Trustees will hold a special meeting to receive bids on $120,000 sewer and $50,000 water bonds. The bonds will not be formally sold however until later.

PORTLAND, CAL.—The Portland Railway, Light & Power Company will increase its capital stock from $15,000,000 to $25,000,000 in order that much needed extensions throughout the city may be made.

ESCONDIDO, CAL.—At a directors' meeting of the Escondido Mutual Water Company an assessment of 5 cents per share was levied in order to continue the work of replacing wooden flumes on the San Luis Rey river with a tunnel and stone and cement ditches. The water pipes will be extended into the tract of the Escondido Development Company, in South Escondido.

ALTURAS, CAL.—The Trustees have issued a call for a bond election to be held in January, 1911, to act on a proposition to issue $33,000 in bonds for waterworks and $2000 to raise funds for a fire equipment, making an issue of $35,000. It is proposed to have the bonds for water works extend over a period of 40 years, to be paid in equal annual payments of $1000 each, with interest at 5 per cent per annum.

LOS ANGELES, CAL.—The Southern California Gas Company has issued $10,000,000 in first mortgage 40-year gold bonds. The Trust Company of America is named as trustee. Several months ago, the gas company acquired the holdings of the Domestic Gas Company and is issuing the mortgage to redeem certain bonds issued by the original company. The remainder of the money raised will be expended in completing the Redondo plant and extending the gas mains to San Bernardino.

ILLUMINATION.

PASADENA, CAL.—Preparations are being made to increase the capacity of the Pasadena municipal light plant.

LEWISTON, ORE.—The City Council has passed in amended form, a franchise to E. H. Libby, for 25 years, to carry on a light, heating and power business in the city of Lewiston.

FRESNO, CAL.—Hereafter the office of the purchasing agent for the San Joaquin Light & Power Company will be in Fresno instead of Los Angeles. J. H. Newlin will occupy the office. As heretofore the company will invite competitive bids for all bid orders.

CHEHALIS, WASH.—Heller, Sinclair & Anderson, who are interested in the Twin City Light & Traction Company in a directors' meeting in this city authorized the expenditure of $100,000 for improvements of permanent natures. A large power house will be constructed.

OROVILLE, CAL.—During the year of 1911 the Oro Water, Light & Power Company will spend $70,000 in improvements upon its local distributing system of water, electricity and gas in this city. The announcement was made by Manager R. L. Van der Naillen.

MERIDIAN, CAL.—Engineers in the employ of the Pacific Gas & Electric Company are busy here making a survey of the streets. The company is preparing to extend its power line from here to Colusa. Power will also be available for the reclamation districts between here and Colusa.

CANYON CITY, ORE.—The Eastern Oregon Light & Power Company is making arrangements to install a power plant at Lagoon lake and furnish power and light for the John Day valley. W. C. Parrish of Baker City, who has been here some time making arrangements, will in a short time be in a position to enter into contracts for light and fuel.

ELMA, WASH.—The Olympia Railroad & Power Company of this place announces that New York capitalists are coming here within a short time to look over the company's holdings and will buy same or finance the company in its development of power and transportation plans, which include the harnessing of water powers and furnishing of light and power for all the cities of southwest Washington.

JACKSON, CAL.—The Board of Supervisors has passed an ordinance granting to John L. Henry a franchise to erect and maintain along the public highways and alleys, in Township No. 3, in Amador county, poles and other superstructures upon which to suspend wires and other appliances for the conducting of electric current for telephone and telegraph and for all the purposes to which the same may be adapted.

MERCED, CAL.—Negotiations are now under way between the San Joaquin Light & Power Corporation and the business men of the city looking toward the installation of at least fifty electroliers for street lighting. R. L. Bearden, representative of the company, is at present in the city and has about completed a canvass of the business houses. He has met with success and will send for a representative of the company that does the work of installation of the electroliers.

LOS ANGELES, CAL.—The Domestic Gas Company, lately reincorporated as the Southern California Gas Company, a subsidiary of the Huntington Pacific Light & Power Corporation, has completed its purchase of the City Gas Company by paying to the officials of that concern $1,338,437. The transaction was handled through the banking-house of N. W. Halsey & Company, of San Francisco and New York, and the payment, in the form of a check, was deposited in San Francisco. The money will go to sixty stockholders, all residents of this city. J. F. Sartori, president of the Security Savings Bank, was one of the organizers and head of the selling company, and Captain Randolph H. Miller was a factor in its formation three years ago. When the City Company began to expand, the Huntington corporation, which plans to supply gas to practically all of Southern California, opened negotiations for its absorption and paid the management its own price. The stockholders made an enormous profit on their investments.

TRANSMISSION.

VALLEJO, CAL.—Contractor E. D. Crowley, of San Francisco is preparing to erect a new central power station at Mare Island yard early in January.

PASCO, WASH.—Plans are being drawn in the Portland office of the Pacific Power & Light Company for the largest switching stations in the Northwest. According to present estimate the building will be 200x80.

SAN LUIS OBISPO, CAL.—Plans are being prepared for the construction of an electric railway from this city to San Simeon, and from Cayucos to Paso Robles. A. M. Bianchi of Cayucos and Jas. E. McFee are interested.

TWIN FALLS, IDAHO.—Governor Brady, who controls practically all the stock of the Idaho Consolidated Power Company has announced that $30,000 additional horsepower is to be developed at American Falls during the coming year by the building of a new power house.

SPOKANE, WASH.—Ed. Donlan of Missoula, Mont., president of the Northwestern Development Company, has announced that the construction work on the dam and power station at Thompson Falls, Mont., will start early in spring. The contemplated improvements will cost $1,800,000 and will develop 30,000 horsepower.

RICHLAND, WASH.—Negotiations have about been completed between the Lower Yakima Irrigation Company and the Pacific Light & Power Company for the establishment of a power transmission line to connect with the high tension line of the latter company to furnish power for operating the two pumping plants of the irrigation company.

PORTLAND, ORE.—The Mount Hood Railway & Power Company has purchased a tract of land on the Willamette river for a site for its first auxiliary steam power plant. The contract has been let to Chas. C. Moore & Co. of San Francisco for the erection of the plant, the project to be completed within four months.

LIBBY, MONT.—The Libby Water Works, Electric Light & Power Company has secured a franchise for construction of telephone lines and it is reported work will be commenced in the spring. The company intends building toll lines into the adjacent towns. An electric light system will be installed at the same time. The Barnum Engineering Company of Great Falls, Mont., has charge of the work.

PARKER, ARIZ.—For the purpose of supplying and developing electrical power, to be used for pumping and lighting, plans are being made for the installation of a Price-Current Motor on the Colorado river at a point near Headgate Rock. W. H. Taggart, secretary of the Pacific Current Motor Company, of Los Angeles, was in this city securing data and will return in about a week prepared to enter into arrangements with holders of land for installation of a plant here.

WILLOWS, CAL.—A representative of the Northern California Power Company has made a protest to the Supervisors against the Shasta Power Company entering this county and especially against the latter company placing its pole line on the same side of the road as the line of the Northern company. The Supervisors informed the protestant that his company has encroached on the roadway eight feet with its pole line and had been ordered to remove these poles several years ago but had failed to do so. He was told that his company must take immediate action in obeying the orders of the Supervisors. The franchise for the Shasta Power Company is now being advertised.

SAN JACINTO, CAL.—A party of engineers has arrived here for the purpose of making final surveys in connection with power enterprises of Ramona Power Company, in the San Jacinto mountains. A reservoir site has been purchased of Angelo Domenigoni below Idyllwild. The company obtains rights for power purposes to practically all water in North Fork, Strawberry Creek and South Fork. The waters of these streams will be piped from a point as high up the canyons as possible in order to obtain a maximum drop down to a power house to be located in San Jacinto canyon near the foot of the mountain. After passing through the power house the waters will be returned to the natural sources.

WILLOWS, CAL.—Early in the coming year the Northern California Power Company which already has an electric power line reaching to this place, will begin the construction of a new line 10 miles long that will be supported on 50-foot reinforced concrete poles and will cost $200,000. It will run from the company's new power-house at Coleman, designed by Rudolph W. Van Norden, on Battle creek, Shasta county, through Red Bluff and Corning and to the head works of the Sacramento Valley Irrigation Company's canal system, two miles north of Hamilton City, where the 8000-h.p. current will be delivered to the pumping plant that will lift the water from the Sacramento river into the canal. The line will then come on to Willows, ending here for the present. Later it is to be extended to San Francisco Bay.

TRANSPORTATION.

PRINEVILLE, ORE.—A project is now on foot to build an electric line from here to Redmond by the Crook County Water, Light & Power Company.

SAN FRANCISCO, CAL.—Alleging that the United Railroads is using a patent car fender without license from the patentee, Ira P. Clark, of Decatur, Ill., asks for $24,000 damages in a complaint filed yesterday in the U. S. Circuit Court.

SACRAMENTO, CAL.—The Sacramento Electric, Gas & Railway Company proposes to build connecting lines so as to extend its K street line from Fifteenth to Twenty-first street, and to extend its Twenty-first street line north from Twenty-first and P to K street, to connect with the proposed K street extension.

VANCOUVER, B. C.—Messrs. C. S. Gzowski, C. H. Allen, Walter Gravely et al., are financing a scheme for improvements on Grouse mountain. Several miles of electric railway, costing $38,000 a mile, will be constructed on the slope of the mountain. A charter has been obtained and construction work will start in the spring.

MARTINEZ, CAL.—Work on the Oakland & Antioch Railway is progressing rapidly from Bay Point to Concord and it is the plan of the principals of the road to run the first cars from Bay Point to Walnut Creek on New Year's Eve. The rails have laid to within three miles of Concord, and the

right of way along the entire line has been graded. The work on the sub-station near Concord has been completed and the transformers installed.

PORTLAND, ORE.—Franchises for the entrance of the Mt. Hood Railway into Portland will be asked of the City Council at an early meeting, according to plans now being formulated by R. C. Gillis of Los Angeles, chairman of the board of directors, and C. B. Smith, the local manager in charge of the company's business. Work on the project will begin with all possible haste.

LOS ANGELES, CAL.—The contract has been awarded for the construction of a ten-mile extension of the Los Angeles Pacific Railway from Hollywood to Lankershim, thence five miles west to Kester on the Van Nuys ranch. Palmer, McBride & Quayle got the contract on a bid of $400,000 exclusive of right of way. Construction is to begin at once and the extension is to be completed and ready for operation March 1.

SEATTLE, WASH.—The Puget Sound Electric Railway has recently placed in operation on its main line between Seattle and Tacoma, two handsome high speed interurban cars, one being a combination baggage, smoking and passenger car, and the other a combination smoking, passenger and parlor car. On December 1st, the company established an especially fast limited service between the two cities mentioned, the running time being one hour and 10 minutes. Local trains are operated on an hourly schedule as heretofore, but the running time will be increased from one hour and 30 minutes to one hour and 45 minutes.

VANCOUVER, B. C.—The recent opening of the British Columbia Electric Railway Company's suburban line between New Westminster and Chilliwack, B. C., a distance of 63.8 miles, was attended by a number of leading citizens of Vancouver and Victoria, as well as by the councils of the various municipalities interested, who were guests of the company. The last spike was driven by Premier McBride in the presence of a large gathering. The company now has 200 miles of track on the mainland and 25 miles in Victoria. Other sections of the fertile Fraser valley will in the near future be served by lines to be operated by the Western Canada Power Company, whose great power development plant at Stave lake is approaching completion.

LOS ANGELES, CAL.—The Los Angeles Pacific Company has announced that in 1911 it will sell 60-ride individual commutation tickets for $3, good for 90 days; 30-ride family commutation tickets for $2.10, good for 90 days, and 40-ride school commutation tickets for $1.50 limited to the school term, for use between Los Angeles and Gardena Junction on the line reaching Hollywood and Highland avenue on the line reaching Colegrove. These will be good over any route and transfers will be issued to cars of the company at the termini. The company will also extend the 5-cent fare from Arlington to Vineyard on the Sixteenth street line. The company has informed the Public Utilities Commission of Los Angeles that it cannot consistently honor the present request of the residents of Hollywood and Colegrove for an extension of the straight 5-cent fare to those newly acquired suburbs for the reason that the country between is not thickly populated, there are no compensating short hauls and the bulk of the business would yield only ½ to ¾ of a cent per mile.

TELEPHONE AND TELEGRAPH.

VALE, ORE.—Mr. Labo, superintendent of the Malheur Home Telephone Company, with headquarters at Ontario, Ore., states that the company is making arrangements to put in a complete change in the local system. A plan is now under contemplation for the erection of a brick building in which to move their headquarters.

MONTGOMERY CREEK, CAL.—Herbert Bass of Montgomery Creek, president and lessee of the Redding, Ingot and Wengler Telephone Company, has arranged for the extension of the line. The company, which was organized four years ago and of which he was the original promoter, is capitalized at $10,000.

POMONA, CAL.—The Local Home Telephone Company is adding to its switchboard capacity by installing several new sections. This makes the ultimate capacity of the plant 5000 telephones, whereas under the present equipment but 3500 people can be served. The company is enjoying a rapid and steady growth.

ROSEVILLE, CAL.—The Roseville Home Telephone Company has made application to the Board of Trustees for a franchise to erect and lay telephone wires and to erect poles for such purposes in the streets, alleys and ways of the city of Roseville. The franchise will be sold to the highest bidder on January 2d.

ABERDEEN, WASH.—Negotiations have been about completed for the construction of a telephone line to connect Aberdeen and Westport. The movement, being backed by local shipping people, will when completed enable them to have direct communication with the United States life-saving station at the entrance of the harbor and by this means keep in touch with the arrivals and departures.

LOS ANGELES, CAL.—Charles E. Sumner, of Toledo, Ohio, who claims to own 1000 shares of stock in the Northwestern Long Distance Te'ephone Company, valued at $100,000, has filed suit in the Superior Court against William H. Allen, Jr., and Charles C. Porter, directors of the company. Sumner seeks to recover $55,000 on the ground that unauthorized indebtedness of that amount has been incurred. According to the petition Allen and Porter instructed P. L. Willis, president of the company, to create a bonded indebtedness of $55,000. The complaint states that the two directors control the board and that they are antagonistic to the interests of the stockholders.

WATERWORKS.

BRAWLEY, CAL.—City Engineer Park has been instructed to prepare plans and specifications for a water system on a basis of a cost of $30,000. The remaining $10,000 of water bonds will be used in well work.

RATON, NEW MEXICO.—An earth dam with a concrete core, costing about $150,000, is now being built twenty miles southeast of Raton, New Mexico. M. M. O'Shaughnessy is consulting engineer, and Mr. Smith, late of the Roosevelt dam of Arizona, is resident engineer in charge of construction.

ELY, NEV.—The extension of the mains of the Ely Water Company to the springs at the head of Murry canyon has been discussed by the Council and the city attorney has been instructed to take up the matter with the water company.

OAKLAND, CAL.—That for the four years ending June 30, 1911, the city of Oakland and its residents have saved almost $1,000,000 under the agreement for an annual reduction of the water rates made between the City Council and the People's Water Company, is the substance of a report filed with the Council by J. H. Dockweiler, city water expert. In January, 1907, at which time the People's Water Company purchased the plant from the Contra Costa Water Company, the rates were the same as those in 1903, when the city was enjoined by the Contra Costa Water Company from fixing a lower rate. Since that time there has been a reduction of the rates each year that, to the present time has effected a saving to the city of $117,251.36, and to the consumers $541,804.45. At the same rate, it is figured that at the end of the four years the total saving will be $902,000.

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Syracuse, N. Y.
Spokane, Wash.

Goeriz, O. C. & Co.....
San Francisco, 916 Postal Tel. Bldg.

H

Habirshaw Wire Co.....
New York, 253 Broadway.

Hammel Oil Burner Company ..
Los Angeles, North Main St.

Holtzer-Cabot Elec. Co., The.....
Boston and Chicago.
San Francisco, 612 Howard.

Hughes & Co., E. C..... 5
San Francisco, 147-151 Minna.

Hunt, Mirk & Co..... 6
San Francisco, 141 Second.

I

Ide & Sons, A. L..... 2
Springfield, Ill.

Indiana Rubber & Ins. Wire Co.... 1
Jonesboro, Indiana.

J

Johns-Manville Co., H. W.....
New York, 100 William.
San Francisco, 159 New Montgomery.
Los Angeles, 222-224 North Los Angeles St.
Seattle, 576 1st Ave. So.

K

Kellogg Switchb'd & Supply Co..13
Chicago.
San Francisco, 88 First.

Kiewert, Chas. L. Co..... 3
San Francisco, 195-7 Fremont.
Los Angeles, 225 Franklin Court.

L

Locke Insulator Mfg. Co.....
Victor, N. Y.
San Francisco, Monadnock Bldg.

Los Angeles, Pacific Electrical Bldg.
Seattle, Colman Bldg.

M

Moore, Chas. C. & Co. Engineers. 3
San Francisco, 99 First.
Los Angeles, American Bank Bldg.
Seattle, Mutual Life Bldg.
Portland, Wells-Fargo Bldg.
Salt Lake City, Atlas Blk.
New York City, Fulton Bldg.

N

New York Insl'td Wire Co.....
New York, 114 Liberty.
San Francisco, 770 Folsom.
Seattle, 416 American Bank Bldg.

O

Ohio Brass Co. .....
Mansfield, Ohio.
San Francisco, Monadnock Bldg.
Los Angeles, Pac. Electric Bldg.
Seattle, Colman Bldg.

Okonite Co..... 1
New York, 253 Broadway.

P

Pacific Gas & Elect. Co., The...11
San Francisco.

Pacific Meter Co. 1
San Francisco, 311 Santa Marina Bldg.

Pacific States Electric Co. 16
San Francisco, 137 New Montgomery.
Oakland, 526 Thirteenth.
Los Angeles, 330 S. Los Angeles.
Portland, 90-92 Seventh.

Pacific Tel. & Tel. Co., The.....
San Francisco.

Patrick Carter & Wilkins Co....
Philadelphia, 22d and Wood

Pelton Water Wheel Co., The... 5
San Francisco, 1095 Monadnock Bldg.

Phillips Insulated Wire Co..... 1
Pawtucket, R. I.

Pierson, Roeding & Co..... 4
San Francisco, Monadnock Bldg.
Los Angeles, Pac. Electric Bldg.
Seattle, Colman Bldg.

Portland Wood Pipe Co..... 5
Portland, Ore.

R

Reisinger, Hugo.....
New York, 11 Broadway.

S

Schaw-Batcher Co. Pipe Works..
Sacramento, Cal., 211 J St.
San Francisco, 356 Market.

Simplex Elect'l Co., The .....
Boston, 110 State.
San Francisco, 612 Howard.
Los Angeles, Security Bldg.
Seattle, Alaska Bldg.
Portland, Couch Bldg.

Southern Pacific Co. 15
San Francisco, Flood Bldg.

Sprague Electric Co. 11
New York City, 527-531 W. 34th.
San Francisco, Atlas Bldg.
Seattle, Colman Bldg.

Standard Und. Cable Co..... 1
San Francisco, First National Bank Bldg.
Los Angeles, Union Trust Bldg.
Seattle Office, Lowman Bldg.

Star Expansion Bolt Co.....
New York City, 147-149 Cedar.
San Francisco, 1010 Howard.

Sterling Paint Company, ... 5
San Francisco, 118 First.

T

Technical Book Shop 5
San Francisco, 604 Mission.

Tel. & Elec. Equip. Co. .....
San Francisco, 612 Howard.
Los Angeles, Security Bdg.
Seattle, Alaska Bldg.
Portland, Couch Bldg.

Thomas and Sons Co., R.....
New York, 227 Fulton.
East Liverpool, Ohio.

Tracy Engineering Co..... 5
San Francisco, 461 Market.
Los Angeles, Central Bldg.

V

Vulcan Iron Works..... 1
San Francisco, 604 Mission.

W

Wagner Electric Mfg. Co..... 1
St. Louis, Mo.

Western Electric Co..... 5
San Francisco, 680 Folsom.
Oakland, 507 16th.
Los Angeles, 119 E. 7th
Seattle, 1518 First Ave. So.

Western Wireless Equipment Co.. 3
San Francisco, Grant Bldg. 7th and Market.

Westinghouse. Elec. & Mfg. Co... 6
Pittsburg, Pa.
Los Angeles, 527 So. Main.
Denver, 429 17th.
Seattle, Central Bldg.
Salt Lake City, 212-214 So. W. Temple.
San Francisco, 165 2d.
Spokane, Columbia Bldg.
Portland, Couch Bldg.
Butte, Lewisohn Bldg.
Canada, Canadian-Westinghouse Co., Ltd., Hamilton, Ontario.
Mexico, G. & O. Braniff & Co., City of Mexico.

Westinghouse Machine Co..... 6
Pittsburg, Pa.
San Francisco, 141 Second.

Weston Elect'l. Instrument Co....16
Waverly Park, N. J.
New York, 114 Liberty.
San Francisco, 682-684 Mission.

Wilbur, G. A.....14
San Francisco, 61 Second.